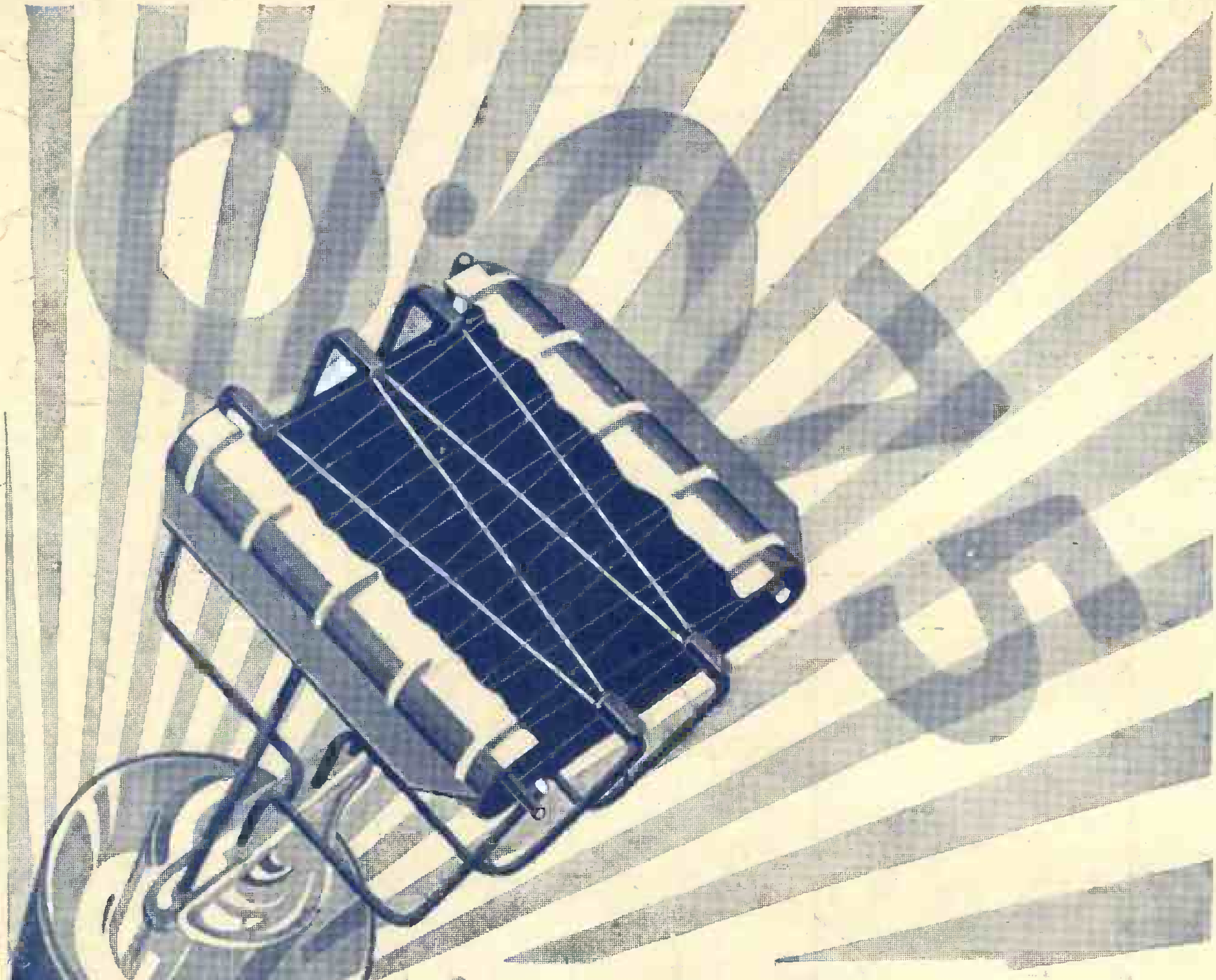
FULL DETAILS OF THE SET OF THE YEAR

MODERN WIRELESS

1/- MONTHLY

Edited by
NORMAN EDWARDS
M.I.R.E., M.R.S.L., F.R.G.S.

Vol. IX. No. 13. JANUARY, 1928.



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A filament with gigantic emission—steady, enduring and powerful, bringing positively improved reception to *any* radio receiver.

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Edited by NORMAN EDWARDS, M.I.R.E., M.R.S.L., F.R.G.S.

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COSSOR

MODERN WIRELESS

Vol. IX. No. 13. January, 1928.

The New Solodyne—" Pressing the Button "—Progress with the Regional Scheme.

The New Solodyne

IN this issue of MODERN WIRELESS we are publishing full constructional details of the 1928 Solodyne.

As many of our older readers remember, the Solodyne, when first described in this journal, created widespread interest, and thousands of amateurs—many in distant parts of the world—have since testified to the remarkable efficiency of the Solodyne circuit.

Since the publication of the full details of the original Solodyne there have been devised many new circuits, and the improvements and developments in radio apparatus have also been numerous.

But fundamentally, the Solodyne still remains a multi-valve-circuit receiver of outstanding superiority; its merit, indeed, needs no laudation here; every amateur has heard of the Solodyne even if he has not built one, and has heard of it in the terms of highest praise.

Some months ago we made arrangements with Mr. John Scott-Taggart—arrangements which have resulted, with his permission, in the construction of a modern and thoroughly up-to-date version of this famous set.

The amateur who constructed the original Solodyne will, on reading the details published elsewhere in this issue, note with interest the improvements which have been made—improvements which are naturally consistent with the development of radio technique. For example, the 1928 Solodyne employs screened-grid valves—and this alone may truthfully be said to have led to an up-to-date Solodyne design which gives extraordinarily fine results as well as providing a welcome economic feature.

We present the 1928 Solodyne to our readers after many months of laborious experiment and after the most rigid tests, and we feel confident that the many thousands of amateurs who will undoubtedly build this magnificent receiver will be more than satisfied with the results they will obtain, and more than repaid for the time spent on the construction of the set.

" Pressing the Button "

" GENUINE pure democracy has been made possible by the advance of science. A large part of Europe can listen to my eloquence and the eloquence of others. In future it is possible that people will be able to listen-in and record their vote ' Yes ' or ' No ' by pressing a button."

Thus Mr. George Bernard Shaw, at a recent meeting, envisaging an era (yet to dawn, thank goodness) when wireless plebiscites will play a part in determining the trend of political power.

Like all very clever men, Mr. Shaw cannot resist the temptation to peer into the future and, on insufficient data, assume that scientific development will eventually make almost anything possible.

As regards voting by wireless, he was probably indulging in an exaggerated example for the purpose of his argument on democracy; but even supposing the day does dawn when every householder has his own wireless transmitting set, and supposing one can record one's political vote by wireless, merely by " pressing a button," is that likely to enhance the value or prestige of " genuine pure democracy ? " We doubt it.

Note, also, how Mr. Shaw makes use of that fascinating phrase " pressing a button."

Surely we are all familiar with that phrase in forecasts of the future and in pseudo-scientific fiction . . . the beetle-browed Professor who, by merely " pressing a button," releases death and destruction, or closes hidden doors—or releases atomic energy. . . . " Pressing a button ! " If democracy has to rely on " pressing a button " in the future it will die of sheer boredom !

Progress with the Regional Scheme

AS we go to press with this issue we learn that the Regional Scheme is still in the experimental stage although " continuous progress is being made." We understand that the final plan will depend a good deal upon the results of 5 G B's experiments—which, by the way, are likely to continue until next August—and then, when a definite scheme has been drawn up, the approval of the P.M.G. will have to be obtained.

The plan at present under review is based on the construction of a high-power station near London to serve London and the South-East of England—another station in the West Country to serve that district and South-Western England and Wales—a station in the North of England to serve the industrial North, a station in Scotland, and a fifth in Northern Ireland. As well as these high-power stations there may be relay stations in densely populated areas.

The above scheme is but a broad outline of the plans upon which the B.B.C. is at present working, and it is considered possible that work on the scheme will commence about the end of 1928.

Some practical notes on the best resistance values to use.

By W. JAMES.

WHEN resistance L.F. amplification is used, a stopping resistance of 100,000 ohms to 250,000 ohms is often recommended for the purpose of reducing the H.F. passing through the detector, and thus getting to the grid of the first L.F. stage. There are three ways of connecting these stopping resistances (grid leaks), as shown in Fig. 1. In scheme A, an extra grid leak R is connected between the grid of the first L.F. valve and the junction of the coupling condenser and the grid leak C and GL.

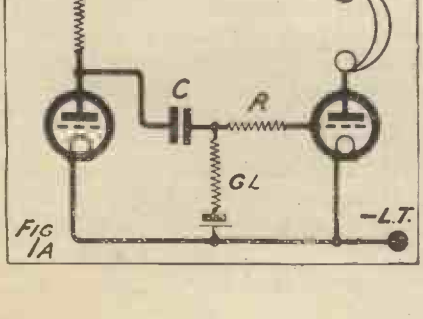
Avoiding L.F. Losses

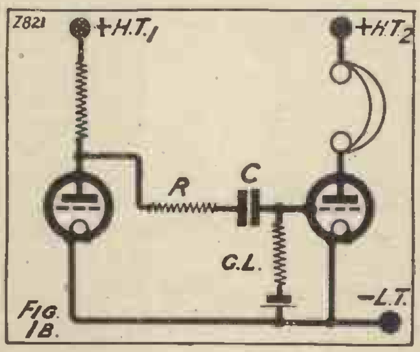
In scheme B, resistance R is joined between the anode and the coupling condenser, while in scheme C, R is connected between the coupling condenser and grid leak. In each of these methods there is a loss in low-frequency amplification. The loss will depend on the value of R compared with the other values.

In the circuit of Fig. 1C, for instance, it is quite easy to see that if resistance R had the same value as the grid leak, half the low-frequency voltage would be lost. In scheme A we lose an amount depending on the impedance of the grid circuit of the first L.F. valve, while in scheme B we lose an amount similar to that lost with scheme C.

A Useful Tip

In each case the reason for the circuit arrangement is this. We put in the path of the high-frequency currents a fairly large resistance, a resistance which is, in fact, high compared with the other circuit impedances at the high frequency. If we consider the grid circuit only, and draw in the self-capacity of the grid circuit, as in Fig. 2, we can easily see that the effect of the resistance R depends on the value of this stray capacity, for the high-frequency currents which flow through the resistance and stray capacity set up a voltage across the condenser which is proportional to its impedance as compared to that offered by the resistance R.



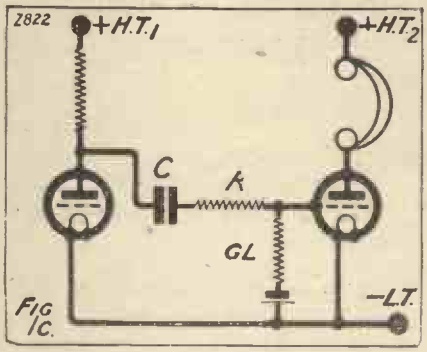


Obviously the amount of high-frequency voltage available between the grid and filament terminals could be reduced by adding to this capacity. This is a useful thing to remember in practice, for it is often found that the addition of a tiny condenser such as 0·00005 mfd. will have the effect of very materially increasing the effectiveness of the resistance R in absorbing the high-frequency currents.

Stray Capacities

In practice the stray capacity represented by condenser C may amount to as much as 50 micro-micro-farads, which at 750 kilocycles has an impedance of about 4,000 ohms. If the impedance in series with it amount to, say, 100,000 ohms (R), then only quite a small proportion of the H.F. voltage is applied to the grid.

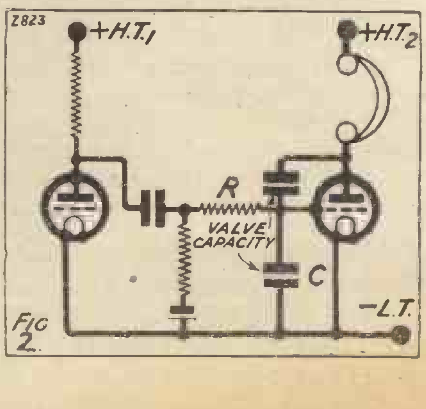
As a matter of fact, there are other stray capacities associated with the circuit which should be taken into account. For instance, there is the capacity of a detector valve between anode and filament. This capacity is not very large, but still it serves as a shunt path for a small amount of high-frequency current. We could add to it if we cared, by putting a condenser between the anode and filament. This would further assist in limiting the amount of high-frequency reaching



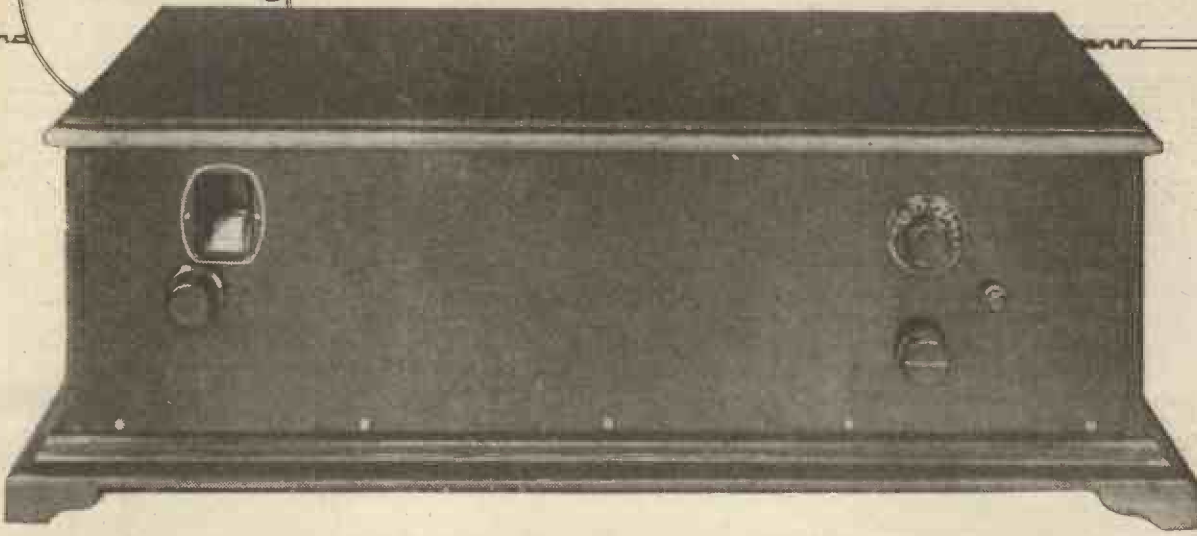
the L.F. stage, and if it is of only small value, such as 0·0001 mfd., it would have no material effect on the quality.

A Detector Improvement

A condenser connected between the anode and filament is really very necessary from the point of view of the effectiveness of the rectifier. Practical experience which agrees with theoretical considerations indicates that 0·0003 mfd. is about the minimum value which should be used in the anode circuit on the lower broadcast wave-lengths. Failure to connect this condenser will often result in weak signals, particularly when anode-bend detection is used, and as by suitably proportioning the low-frequency part of the anode circuit we can make its effect on the low-frequency currents quite negligible, a condenser of this value at least should usually be employed.



This Year's "SOLODYNE"

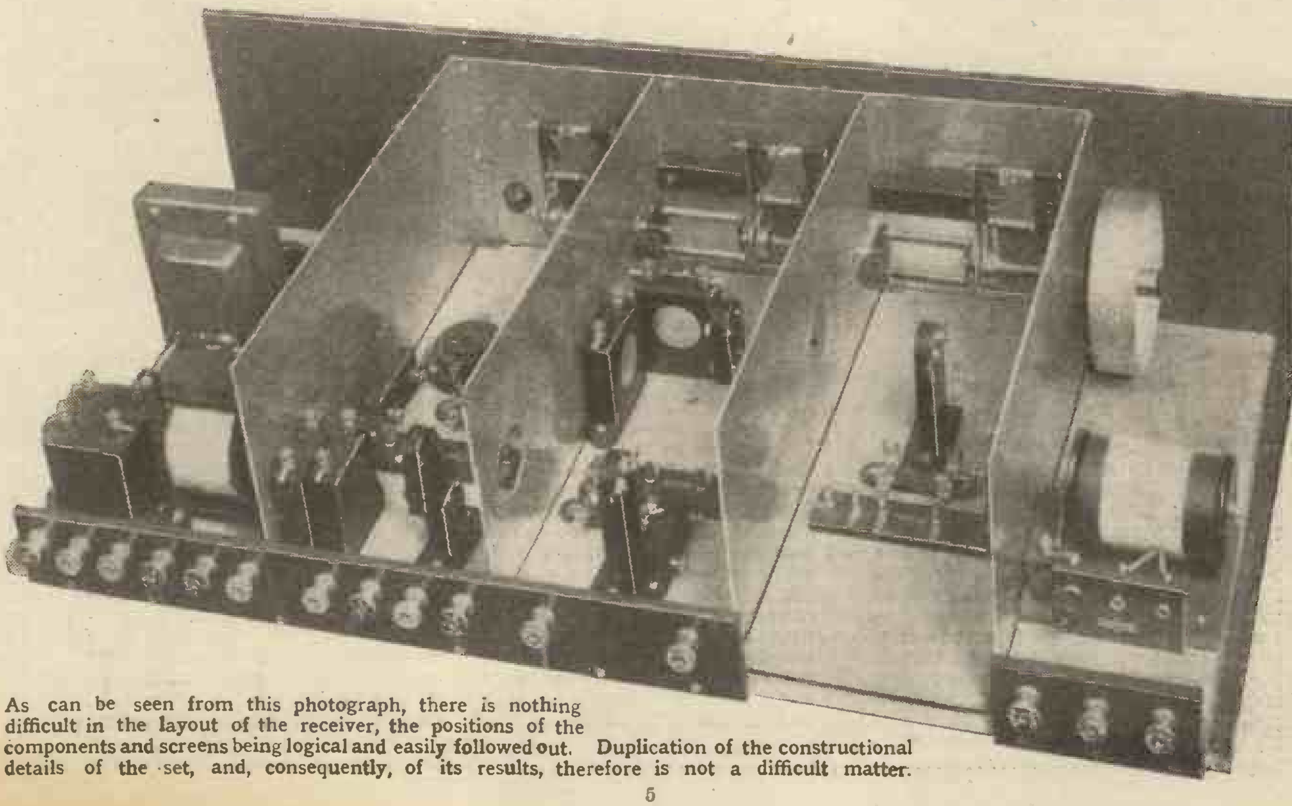


By special arrangement with Mr. John Scott-Taggart, A.M.I.E.E., F.Inst.P., we give below full and exclusive details of the 1928 Solodyne. Embodying all the latest improvements, this magnificent single-control set represents the highest standard of efficiency obtainable with modern components.

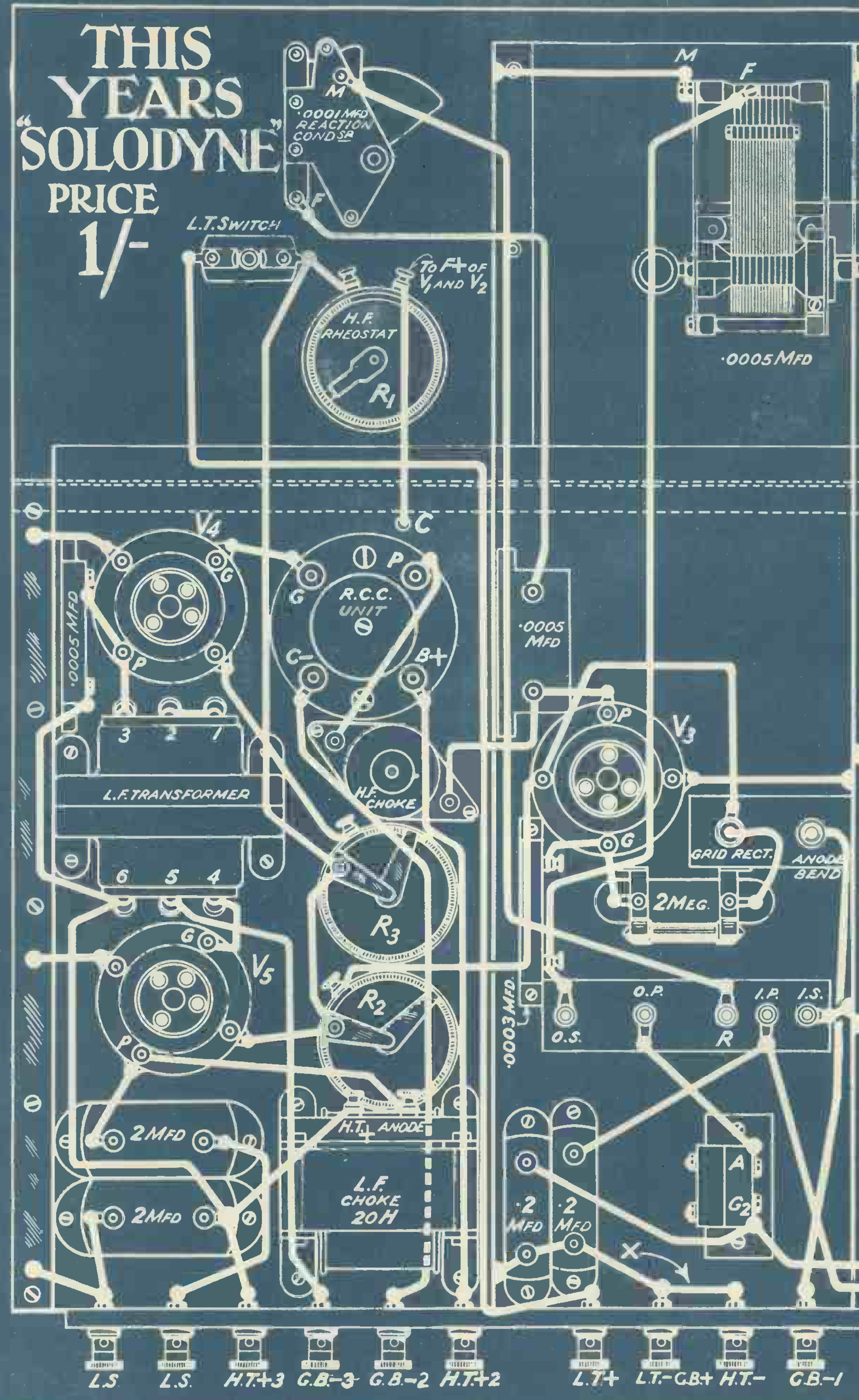
A wonderful quality of reproduction and excellent distance-getting properties make it extremely unlikely that this set will be superseded for a very long time to come.

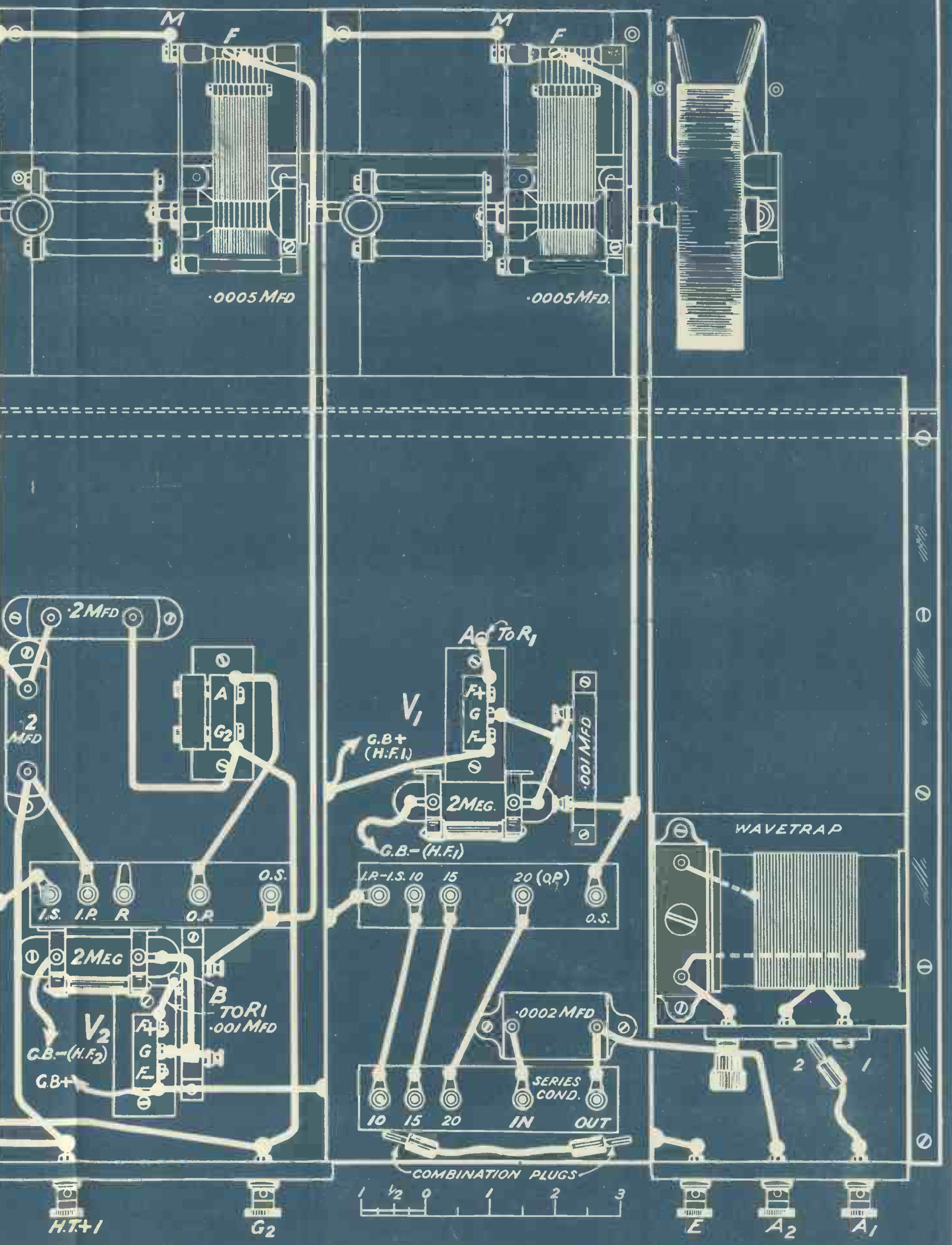
Designed and built in the "M.W." Research Laboratories.

In last month's article describing the preliminary experimental work done in producing the modernised version of the Solodyne, I described the investigations carried out on the semi-astatic type of coil chosen for use in this set, and it will be remembered that it was found that coupling effects to the aerial were extremely similar in the case of this coil and the more familiar cylindrical type. The general problems arising from the use of these coils have necessarily been investigated somewhat fully, and there are certain other points which remain to



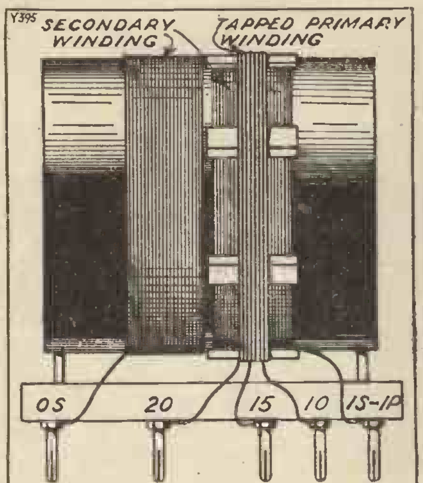
As can be seen from this photograph, there is nothing difficult in the layout of the receiver, the positions of the components and screens being logical and easily followed out. Duplication of the constructional details of the set, and, consequently, of its results, therefore is not a difficult matter.


THIS YEARS "SOLODYNE"
PRICE 1/-
M
·0001 MFD REACTION CONDSR
F
L.T. SWITCH
TO F+ OF V1 AND V2
H.F. RHEOSTAT
R1
M
F
·0005 MFD
C
V4
G
P
R.C.C. UNIT
G
C-
B+
·0005 MFD
·0005 MFD
P
V3
3 2 1
L.F. TRANSFORMER
H.F. CHOKE
G
GRID RECT.
ANODE BEND
6 5 4
2 MEG.
R3
G
V5
R2
P
·0003 MFD
O.P.
I.P.
I.S.
O.S.
R
2 MFD
H.T.+ ANODE
2 MFD
L.F. CHOKE 20 H
·2 MFD
·2 MFD
A
G2
X
L.S.
L.S.
H.T.+3
G.B.-3
G.B.-2
H.T.+2
L.T.+
L.T.-G.B.+
H.T.-
G.B.-1


M
F
M
F
·0005 MFD
·0005 MFD.
·2 MFD
2 MFD
A
G2
A TO R1
V1
F+
G
F-
G.B+ (H.F.1)
·001 MFD
2 MEG.
G.B.-(H.F.1)
WAVETRAP
I.S.
I.P.
R
O.P.
O.S.
I.P.-I.S. 10
15
20 (O.P.)
O.S.
2 MEG
B TO R1
·001 MFD
V2
G.B.-(H.F.2)
G.B+
·0002 MFD
SERIES COND.
10
15
20
IN
OUT
2
1
COMBINATION PLUGS
1 1/2 0 1 2 3
H.T.+1
G2
E
A2
A1

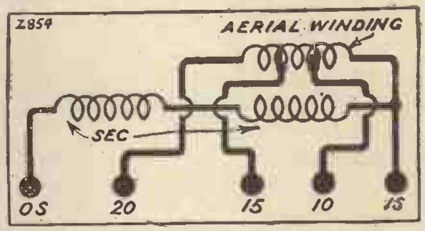
be discussed before we proceed to deal with the details of the final 1928 Solodyne itself.

It was obvious that a really modern version of this receiver should employ the new shielded valves, and this immediately raised the question of the type of inter-valve coupling to employ. It was, of course, evident that further questions concerning the special coils were likely to arise when this decision had been made. The conventional method of employing these valves is, it will be remembered, the tuned-anode circuit, and this is no doubt one of the most logical arrangements when it is intended to obtain the maximum possible amplification from each stage. Where two of these valves are employed, however, it is arguable that the full amplification which could be obtained under the most favourable conditions is greater than would ever be required for normal purposes, and after consideration it was decided that it would be permissible to sacrifice a certain amount of magnification in order to achieve certain other desirable features.



DETAILS OF THE AERIAL COIL.

For example, to obtain a suitable degree of selectivity with a plain tuned-anode circuit it is required that the inductances employed shall be of very low high-frequency resistance, and although this also means that a high degree of amplification will be obtained it may be found in some cases that the receiver may be brought dangerously near to the oscillation point under certain conditions.



This diagram gives the scheme of connections for the coil shown opposite.

With extremely low-loss circuits only a very small amount of feed-back would be required to produce oscillation.

COMPONENTS REQUIRED

Panel, 26 in. × 7 in. × $\frac{1}{4}$ in. (original is Resiston, but, of course, any good branded material can be used, such as Becol, Ebonart, Trolite, etc.).

Cabinet to fit, with baseboard 12 in. deep and $\frac{3}{8}$ in. thick; $\frac{1}{2}$ in. thick also suitable (original is by Peto-Scott). (Artcraft, Camco, Caxton, Makerimport, Pickett, Raymond, etc.) Note: Panel brackets are not used since the panel carries little weight.

1 Special 3-gang condenser, ·0005 each section, with set of special screens (original is by Jackson Bros., but see text).

1 Drum drive for gang condenser, if not provided with the condenser (original is the vernier-type Silver Marshall, obtainable from Messrs. Rothermel).

1 ·0001-mfd. miniature variable condenser (Cyldon "Bébé"). (Igranic, Ormond, Peto-Scott, etc.)

1 Panel-mounting filament rheostat, about 10 ohms (G.E.C. plunger-type, 12 ohms). (Burndept, Igranic, Lissen, Peerless, etc.)

1 On-off switch (L. & P.). (Benjamin, Lissen, Lotus, etc.)

1 Standard wave-trap (Burne-Jones). (Any standard make, or see "M.W." for July, 1927, for home construction details.)

3 Special coils (Burne-Jones seen in photos. Any good make to the specification given elsewhere).

4 Coil bases ("Special Five" type). (See above.)

2 Shielded-grid valve holders (Parex in the original set. Other good makes, such as the Colvern, can be chosen, with suitable slight modification in the method of mounting, position of holes in screens, etc.).

Fixed condensers as follows: One ·0002 mfd., two ·001 mfd., one ·0003 mfd., two ·0005 mfd. (only one ·0005 mfd. if a different make of L.F. transformer is chosen). These are all mica condensers, and those in the actual set are a mixture of the following makes: Clarke, Dubilier, "Goltone," Lissen, Mullard. Any other good make, such as Igranic, T.C.C., etc., may, of course, be chosen.

Mansbridge-type condensers as follows: Four of ·2 mfd. and two of 2 mfd. (Lissen in the actual set. Any good make, such as Dubilier, Ferranti, G.E.C., Hydra, Mullard, T.C.C., etc.).

3 plugs and 2 sockets (Clix, Eelex, etc.).

2 Grid leaks of 1 meg. (see text), and 1 of 2 meg. (Dubilier, Lissen, and Mullard in set. Any other good make, such as Igranic, etc.).

3 Grid-leak holders (Lissen "Combinators," Dubilier "Dumetohm holders," etc.).

1 Fuse holder, if desired (Burne-Jones, Eelex, etc.). (See text.)

2 Baseboard rheostats, about 7 ohms, or to suit valves (Lissen in set. Any good make: Bowyer-Lowe, Burne-Jones, Igranic, McMichael, etc.). Alternatively fixed or semi-variable resistors to suit valves (Burndept, Cyldon, Ormond, Peto-Scott, etc.).

3 Sprung valve holders (Ashley, Benjamin, Bowyer-Lowe, B.T.H., Burndept, Burne-Jones, Igranic, Lotus, W.B., etc.).

1 H.F. choke (Burne-Jones). (Any good make: Bowyer-Lowe, Climax, Colvern, Igranic, Lissen, Marconiphone, Ormond, R.I. & Varley, etc.)

1 Resistance-capacity coupling unit, with anode-resistance value of about 250,000 ohms (Mullard in the set). (Any good make with the correct anode resistance can be used, e.g. Dubilier, Lissen, Marconiphone, R.I. & Varley, etc. See text on this point.)

1 L.F. transformer of fairly low ratio (R.I. & Varley "Straight-line" in the set). (Any good make: Ferranti, Marconiphone, etc., etc. Note: If another make is chosen, omit the fixed condenser of ·0005 mfd. across the primary.)

1 L.F. choke of about 20 henries inductance, capable of carrying the anode current of a super-power valve without risk of saturation, and of low D.C. resistance (R.I. & Varley output-filter type in the set). (Any good make which conforms to these requirements.)

1 Terminal strip, 16 in. × 2 in. × $\frac{1}{4}$ in., with terminals arranged as per blue print.

1 ditto, 4 in. × 2 in. × $\frac{1}{4}$ in.

15 Terminals, engraved or marked as per blue print (Eelex). (Belling & Lee, Igranic, etc.)

1 Ebonite strip, $2\frac{1}{4}$ in. × 1 in. × $\frac{1}{4}$ in., to carry the two sockets for the alternative connections for the rectifier valve.

2 Small dry cells (Siemens type "T" in the photos).

1 Sheet of copper or aluminium, 26 in. × 12 in. × $\frac{1}{32}$ in. (This will be supplied with the cabinet in some cases).

4 False baseboards, all $\frac{1}{2}$ in. thick; 3 to be $4\frac{15}{16}$ in. wide (to fit easily into compartments nominally 5 in. wide), 1 to be 6 in. wide and 1 only $3\frac{3}{4}$ in. All 12 in. long.

Quantity of No. 18 tinned copper wire, or Junit, and supply of Systoflex (see text regarding other materials).

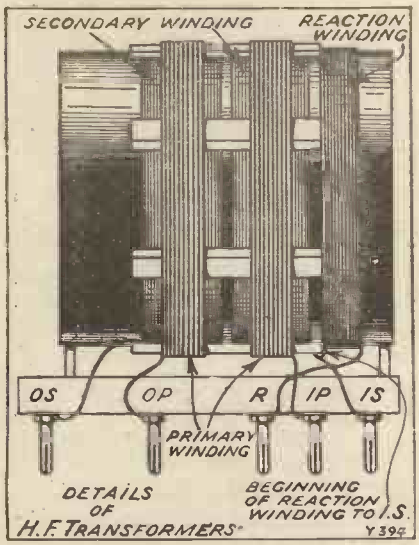
Small quantity of flexible wire.

NOTE.—In many instances in the above list the actual make of component used in the set is quoted immediately after the item. Immediately following this will be found a few alternative makes in alphabetical order. It is not, of course, possible to give all the possible alternatives, nor is it desired to indicate a preference.

It would, therefore, seem desirable in a set in which it was desired to secure a very high margin of safety to arrange to obtain the desired selectivity by weakening the coupling between the valves in some suitable manner, although in so doing there may be some loss of amplification.

Screening Requirements

As an alternative to the simple tuned anode it would be possible to employ a tapped-anode circuit, but this method of coupling does not fulfil one of the other requirements of the ideal which we were seeking, namely, that all the tuned circuits should be at earth potential, or rather at filament potential, to simplify the screening arrangements in the construction of the set. This was desirable, of course, in order that the



lower ends of all the tuned circuits might simply be connected to the nearest point on the screening system.

A system of coupling which satisfies this last requirement is the parallel-feed circuit, but it was considered probable that in this particular receiver the desired results might be more easily obtained by means of transformer coupling, such transformers to be arranged with fairly tight coupling between primary and secondary in order to provide the necessary high impedance in the output circuit of the valve.

Primary Size

A reduction in the size of the primary will naturally enable one to increase selectivity without producing instability, while the high-frequency resistance of the coils concerned can be chosen of some suitable value to obtain the desired conditions as regards even amplification of side-bands in the particular receiver under consideration.

A reduction in primary size will naturally vary both selectivity and amplification, and, therefore, some experiments were undertaken with a view to ascertaining the exact effect of primary size upon these two factors in the case of the particular coil chosen. These coils, it will be remembered, are of the semi-astatic type with a secondary winding consisting of two single-layer coils side by side upon the same tube, but wound in opposite directions. A primary winding to couple with this secondary may also evidently be divided into two sections, wound in opposite directions and superimposed upon the appropriate sections of the other winding.

A number of these transformers were made up and measurements

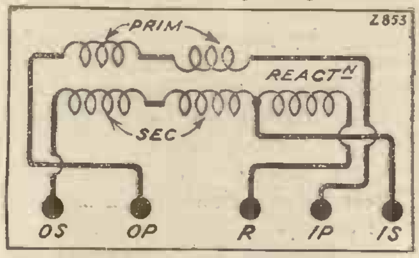
WHAT "THIS YEAR'S SOLODYNE" HAS DONE.

1. On a poor outdoor aerial 12 ft. high at one end and 15 ft. at the other, it has logged 47 stations on the loud-speaker (not all on the same evening). All on the lower band of wave-lengths, and without intensive use of reaction.

2. Brought in 17 distant stations on the loud-speaker on an indoor aerial in 9 minutes (after dark).

were made by means of a valve voltmeter of the degree of amplification obtainable with various sizes of primary, and comparisons were made between these figures and those which were to be got with an ordinary tuned-anode circuit of a similar high-frequency resistance.

It was found that a very considerable reduction could be made in the size of the primary winding without beginning to lose amplification to an extent which was considered unjustifiable in the case of a receiver employing two of these high-magnification



The connections to the H.F. transformers shown in the diagram in the first column

stages (not more than, say, 20 per cent loss). When the point was approached at which the amplification fell below the level necessary to give the performance which we were seeking, a considerable improvement in selectivity had been obtained, even with coils of a very moderate "low-loss" standard.

Selectivity

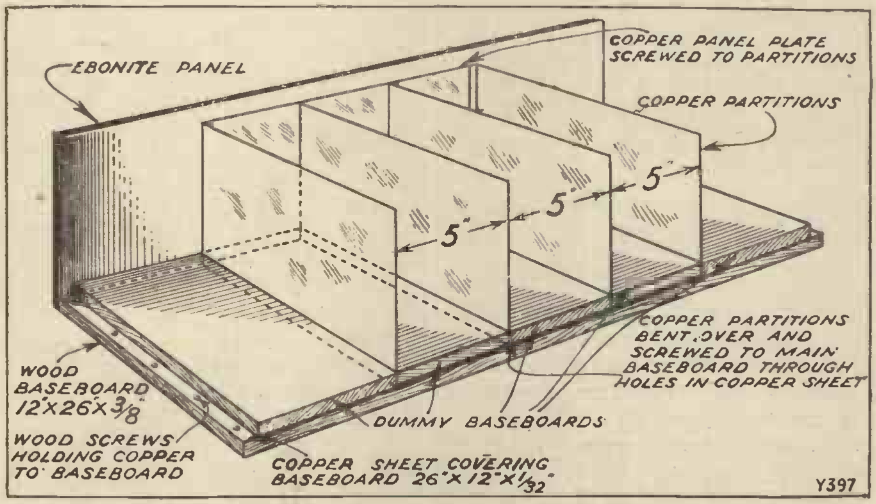
Resonance curves were plotted when using this method of coupling,

The author of this article arranging the positions of the components, a task which has to be very carefully undertaken in order that maximum efficiency be ensured.

and these showed a very considerable sharpening in favour of a transformer on these general lines. This argument, of course, must be understood as applying to this particular receiver and not to screened valve sets in general, since it must be realised that it was the intention to confer certain special characteristics on this set, in particular as regards its suitability for gang control, which obviously demands, among other things, the greatest possible similarity in all the tuned circuits.

"Safety"

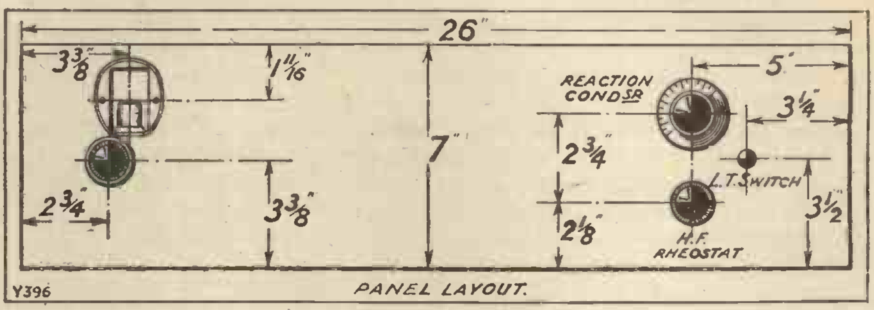
This brings us to the end of the main features investigated in preliminary experiments, and we can turn now to the general aspects of the set as a whole. First, a word or two as to the kind of receiver which we have tried to produce. Now, we have most definitely *not* endeavoured to create a super-selective, super-sensitive set capable of bringing in hosts of far-distant stations regardless of quality of reproduction, ease of handling, and "safety." By this latter expression I mean that quality of a design which renders it more or less sensitive to small changes of layout, partly run down batteries, and so on, and it is a most important feature in any set capable of so high a degree of magnification.



High Standard

On the contrary, the aim has been to produce a receiver capable of a performance carefully adjusted to what seems to us a desirable standard as regards the number of stations which can be brought in. This standard was arrived at as follows: The set must bring in with a high degree of purity all those distant stations *which are normally worth listening to*, even under quite adverse conditions, and without the use of reaction. Further, in order to please the DX enthusiast, it must bring in an adequate number of "the others," i.e. the stations which are interesting to pick up and log, but whose quality for one reason or another renders them unfit for consumption as entertainment.

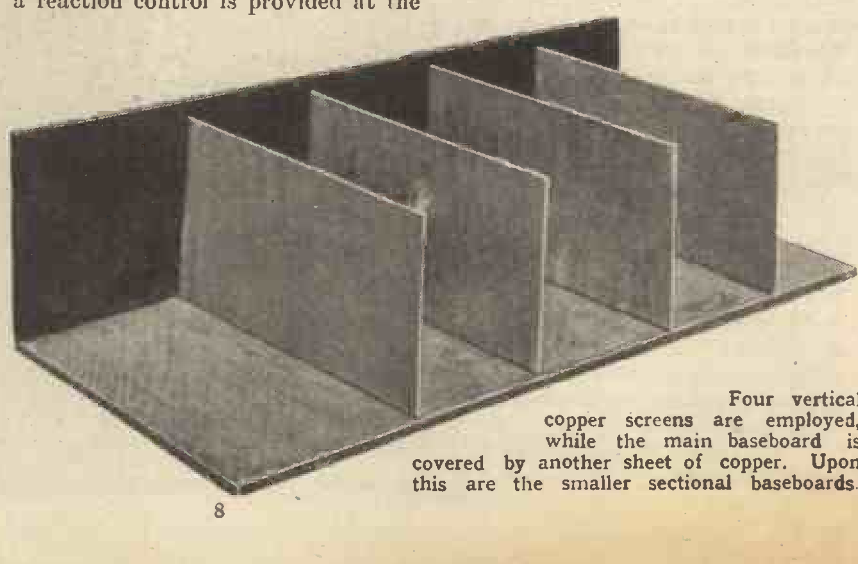
To carry out faithfully the "one dial" idea it is required that all this be done in the simplest possible manner, without critical adjustments anywhere, and therefore the receiver has been arranged to give enough amplification to perform practically all its work without reaction. True, a reaction control is provided at the detector stage, but this is only intended for use in quite exceptional circumstances. It will normally be placed either at zero or at a very small setting, and not touched at all during operation. The banishment of reaction, of course, is very desirable from the point of view of quality of reproduction, and this is one of the features which enables the 1928 Solodyne to bring in numbers of distant stations at a standard quite comparable with that of a local station.



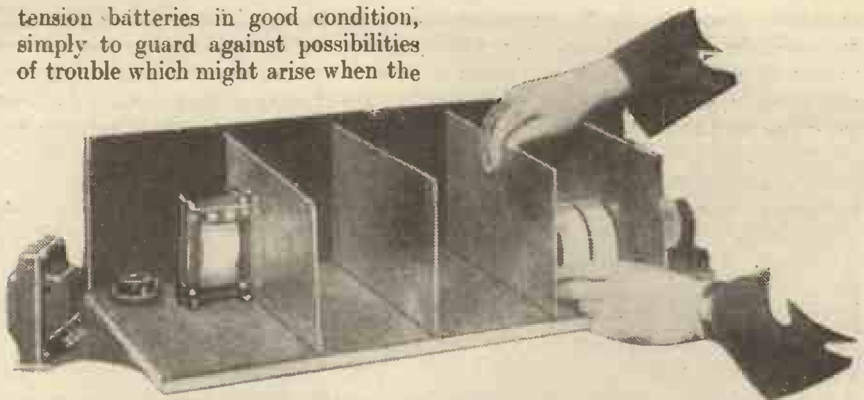
PANEL LAYOUT.

Selectivity

Then as regards selectivity it was considered that to provide an extremely high standard was contrary to the main aim of the design, since a somewhat reduced degree of selectivity is found desirable from the point of view of quality; and also there is the very important fact that if the tuning of each circuit is not too sharp the adjustment of the gang condenser is much easier and less critical, and, further, the effect is much less serious if the circuits do not quite keep step over the whole of the tuning range. The degree of selectivity provided, therefore, is such as has been found quite adequate for separating distant stations; while to remove troubles in eliminating a powerful local station there is a built-in wave-trap of the


Four vertical copper screens are employed, while the main baseboard is covered by another sheet of copper. Upon this are the smaller sectional baseboards.

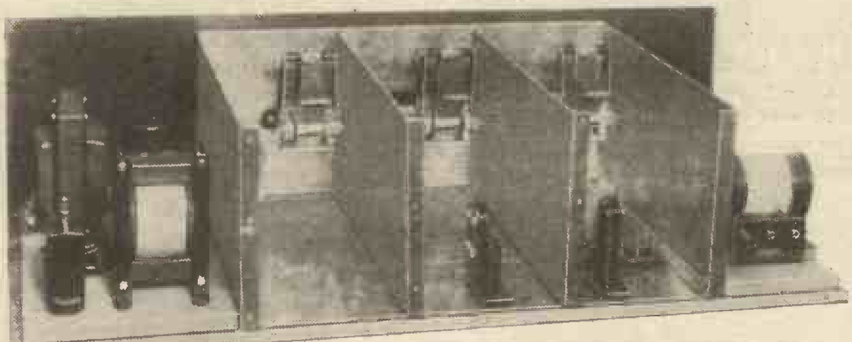
standard "M.W." type. Altogether, the selectivity is of a standard quite sufficient for normal purposes, without sharpening up the tuning by means of the reaction control. All that has been done is to resist the temptation to provide tuning of the razor-edge variety so beloved of some long-range enthusiasts. When, in special circumstances (e.g. where shipping is troublesome), it is necessary to increase selectivity, it can be done in ways which we shall be considering at a later date in dealing with operating details.



An early stage in construction. Testing the distances of components and screws in the first experimental model.

Precautions

Turning now to the question of "safety," here are one or two points which the reader should understand before proceeding farther. It must be understood that with any receiver employing two H.F. stages giving a very high degree of magnification somewhat elaborate precautions must be taken to ensure perfect stability, and, further, that a considerable margin must be allowed to guard against the possibility that if slight modifications are made in the set, in the way of small changes of layout, incorrect spacing of wiring, and many other points, it might become unstable. This is one of the points which comes under the heading of safety in designing a set of this nature, which it is desired to render a proposition which can be made up with the greatest possible assurance of success by anyone who cares to make a reasonably exact copy.



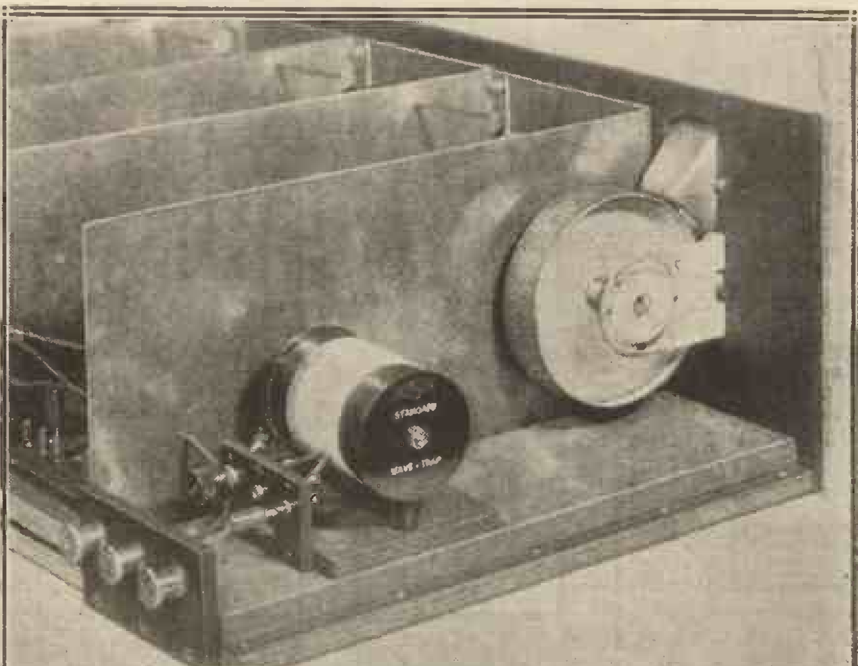
With the gang condenser and a few of the components mounted. Arranging preliminary layout details with experimental screens. The various sections of condenser are not coupled together.

Reserve of Safety

Considerable pains have been taken to render the set as safe as possible, and actually a greater reserve of safety, so to speak, has been provided than will in the majority of cases be necessary. For example, the amount of screening used is greater than is necessary in the original receiver, where all wiring is carefully spaced and which is normally run from high-tension batteries in good condition, simply to guard against possibilities of trouble which might arise when the wiring is perhaps not very skilfully done and when high-tension batteries are employed which are nearing the end of their life and consequently possess a high internal resistance. It would probably be of little interest to the majority of readers to go farther into the various precautions which have been taken in the design to render it as safe as possible to copy, and the point is only mentioned here lest the reader should be puzzled by certain features which may not seem to have a very obvious use.

The Circuit

With so much for preamble, it will now probably be of interest to run briefly through the circuit diagram and note the various features. Starting at the aerial, it will be observed that two alternative terminals are provided, one of which brings into use the integral wave-trap for the purpose of eliminating the local station when receiving others on nearby wave-lengths. The other terminal cuts out the trap when it is not required. Tracing the aerial circuit a step farther, there is a fixed condenser of ·0002 capacity which can be



A "close-up" of the wave-trap and the drum drive for the gang condenser. The end of the bottom copper sheet can be seen protruding beyond the dummy baseboard.

brought into use in series when required to increase selectivity by means of an arrangement of plugs and sockets. A combination of the same arrangement of plugs and sockets also serves to provide a means of varying the number of turns included in the aerial circuit of the coupling winding of the first coil unit.


Nearing the completion of the "mounting" process. Fixing the L.F. transformer in position.

H.F. Grid Bias

The secondary of the first coil unit, together with one section of the gang condenser forms the tuned - grid circuit of the first H.F. valve. We note here that a grid condenser and leak are provided for applying a small negative bias to the grid of the valve in a convenient manner which enables the lower end of the circuit to be earthed to any adjacent point on the screens. This arrangement is provided in the grid circuit of each valve, and the question of the value of the grid leaks is one which we shall be considering later since this will normally be either 1 or 2 megohms according to certain requirements of selectivity, etc.

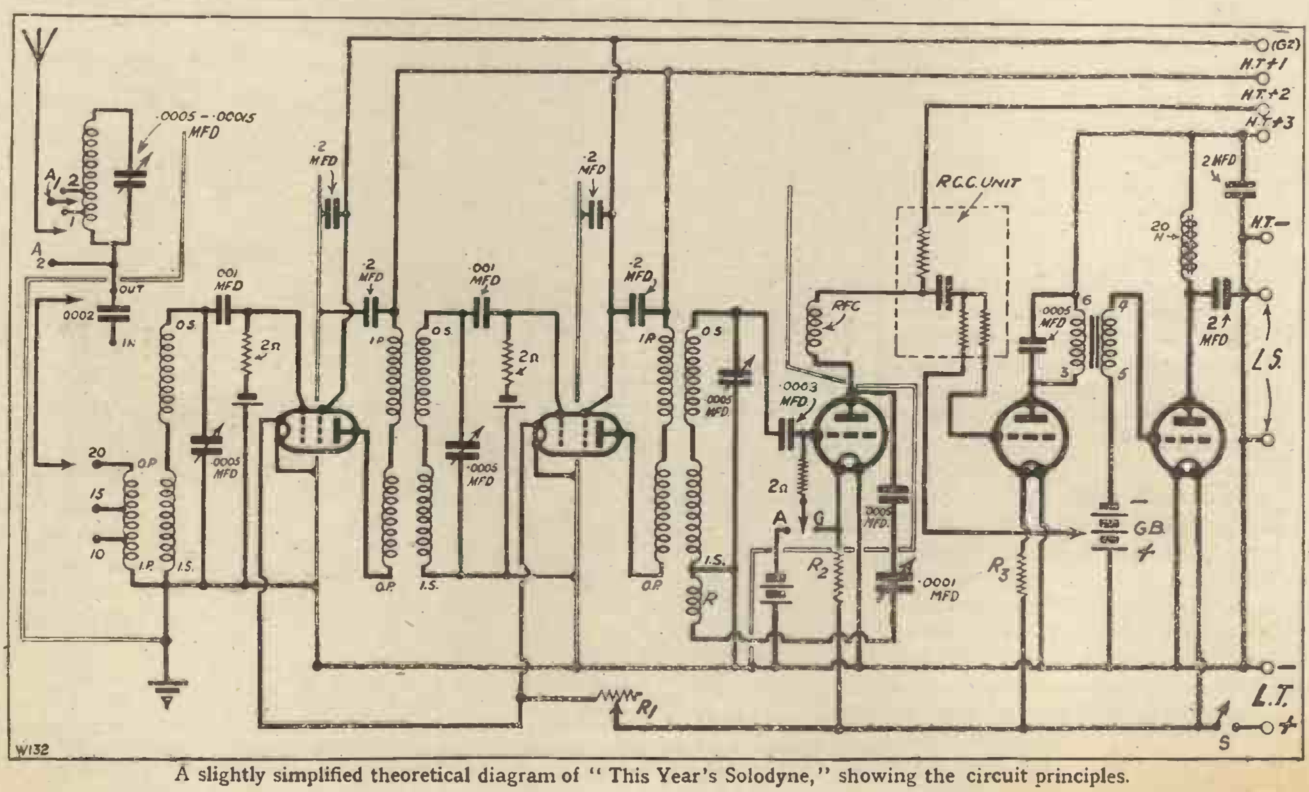
The shielding electrodes of the H.F. valves are taken out to a special terminal along the back of the set, marked G_2 (to conform with the marking of the particular make of valve socket employed in the set). Each of these leads is by-passed to the nearest convenient point on the screens through a Mansbridge type condenser of ·2 mfd. In the anode circuit of each valve is the primary winding of the H.F. transformer and from the H.T. lead to each of these there is again a ·2-mfd. condenser direct to a convenient point on the screens.

The Rectifier

The grid circuit of each valve is, of course, similar to all the others, with a slight difference in the case of the detector valve, where provision is made for either grid-condenser rectification or anode-bend. The lower end of the detector valve grid leak is taken out to a short flexible lead bearing upon its end a small plug which can be inserted in either of two sockets mounted in a small strip of ebonite. One of these sockets is wired directly to filament positive and the other to a grid-bias terminal along the back of the set to enable anode-bend rectification to be obtained when desired.

Reaction

In the anode circuit of the detector valve there is a high-frequency choke, and from this a lead goes off to a ·0005 fixed safety condenser, from which a lead goes on to a small variable condenser mounted upon the



A slightly simplified theoretical diagram of "This Year's Solodyne," showing the circuit principles.

panel for reaction control. Reinartz reaction of the usual type is provided by means of a small winding upon the same tube as the secondary of the H.F. transformer.

L.F. Coupling

Coupling the detector valve to the first low-frequency valve is a self-contained resistance-capacity unit which can be of any good make provided that the anode resistance is of about 250,000 ohms. The actual component used in the set is the new Mullard unit, and it should be noted that this incorporates a device for preventing high-frequency currents from passing on into the low-frequency circuits. If some other make is chosen it will be necessary to break the lead shown to the grid of the next valve and insert in series here a fixed resistance of the grid-leak type, of about ·1 or ·25 megohms, that is in the grid lead of the valve V_4.

THIS YEAR'S SOLODYNE
represents a great advance in design, and has the following special advantages :—

1. No neutralising.
2. Ganging less critical and more accurate.
3. Higher sensitivity.
4. Better quality of reproduction.
5. Simple and efficient volume control.
6. Will work with very small aerials.

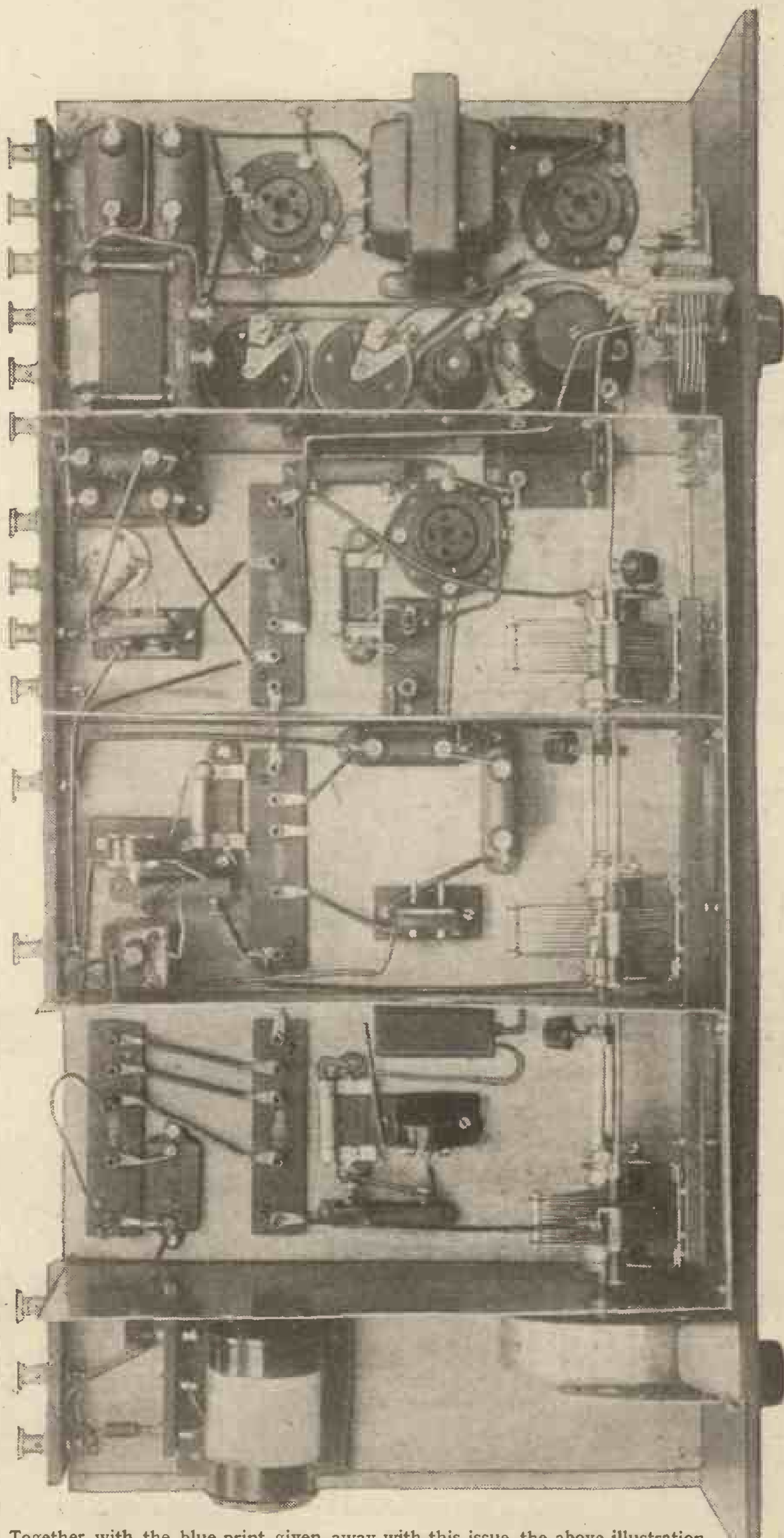
The first L.F. valve is coupled to the last by means of a transformer, which can, of course, be of any well-known make which the constructor may prefer. In the interests of satisfactory reproduction and the protection of the loud speaker an output filter-circuit is used consisting of an L.F. choke of about 20 henries and a 2-mfd. condenser.

Volume Control

One final point before leaving the circuit. It will be observed that a common rheostat R_1 is provided to control the filaments of the two H.F. valves, and this is placed on the panel immediately beneath the reaction condenser. This resistance is intended chiefly as a volume control, in which capacity it will be found extremely useful in bringing all the stronger stations down to manageable proportions.

As a matter of fact, you will probably find that you do not often need to turn the valves full on. The detector valve and the first L.F. valve are provided with separate rheostats, while the last valve has no rheostat, since practically every valve suitable for this position will run satisfactorily straight from a battery of correct voltage for the particular type.

The actual construction of the 1928 Solodyne looks rather involved



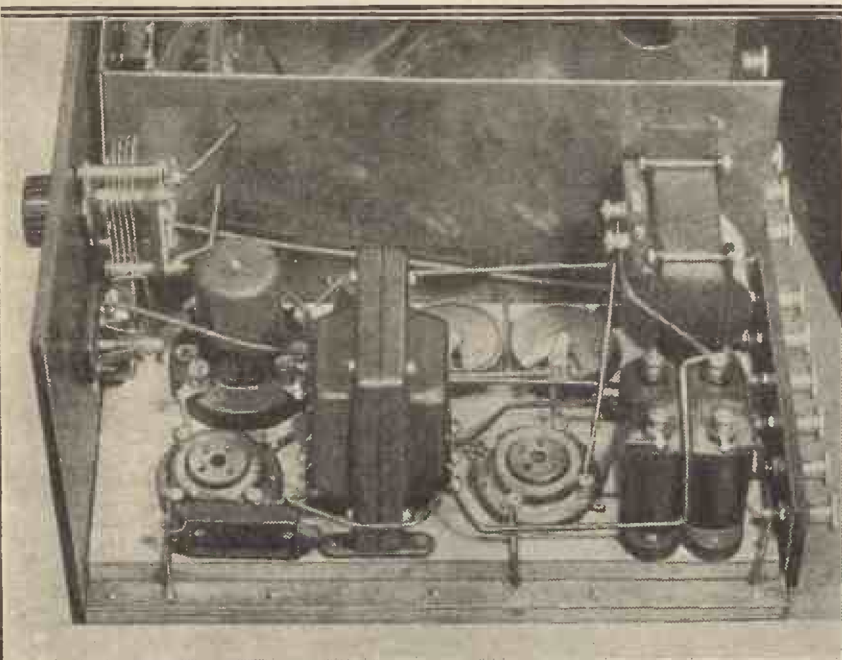
Together with the blue print given away with this issue the above illustration will enable the wiring to be carried out without any difficulty.

in the photos, but you will find that so much of the constructional work is completed for you by the condenser manufacturer and the cabinet-maker that it is really no more difficult to build than any receiver of its size, and certainly not if the comparison is made on a basis of results. First of all, with regard to the screening arrangements: Over the whole baseboard of the set there is a sheet of $\frac{1}{32}$-in. copper, screwed down on the board.

The rest of the screening is assembled in one complete unit with the gang condenser, and this is simply dropped into place and screwed down with small brass screws through the copper sheet and down into the baseboard. The gang condenser, with the set of screens, will normally be supplied complete by the makers, often with the holes for the H.F. valves ready cut.

The Screening System

The vertical screens (of $\frac{1}{32}$ in. copper) which divide the set into compartments form part of the gang condenser assembly, and when this is screwed down upon the sheet of copper which covers the baseboard, the whole screening system is thus bonded together and can be regarded as "earth," so that it may be used



The low-frequency end of "This Year's Solodyne" showing the reaction-condenser connections.

POINT-TO-POINT CONNECTIONS OF THE "SOLODYNE"

All the following components are joined to the copper screening, either by soldering or screws.

One filament socket of each ordinary valve holder to the copper screening system.

One filament socket of each of the H.F. valve holders (screened valves) to the nearest points on the copper screening partitions.

Earth terminal to the nearest copper screen.

Moving vanes of each variable condenser of gang (NOT reaction condenser) to each nearest copper partition.

L.T.— terminal to one tag of each of the ·2-mfd. Mansbridge condensers in the third screened compartment (near the H.T. fuse) to one side of the H.T. fuse (if used), and to the adjacent copper partition.

"I.S." sockets on the coil-holder bases to the nearest copper screens.

Tag of one of the 2-mfd. Mansbridge condensers (in the L.F. compartment) to the end L.S. terminal and to the copper sheet on baseboard.

One tag of each of the ·2-mfd. Mansbridge condensers in the second screened compartment (near centre condenser of gang) joined together and to the copper screen.

Flexible leads for positive elements (brass terminals) on the $1\frac{1}{2}$-volt "T" type cells in the H.F. compartments to the nearest copper screens.

Remaining side of the H.T. fuse to H.T.— terminal.

The remaining filament sockets of the H.F. valve holders (screened valves) are joined together and taken to one side of the variable rheostat R_1 (on panel) through holes in the baseboard. The leads are run in grooves cut in the bottom of the baseboard, and are insulated with Systoflex.

Other side of R_1 is joined to one side of the L.T. switch, to one side of each of the rheostats R_2 and R_3, and to the remaining filament socket of the valve holder V_5.

Remaining sides of the rheostats R_2 and R_3 are joined to the remaining filament sockets of the valve holders V_3 and V_4 respectively.

Other side of the L.T. switch to the L.T.+ terminal.

"Aerial 1" terminal to a plug via a flexible lead. The plug engages with either of the two sockets on the wave-trap.

"Aerial 2" terminal to the "A" terminal on the wave-trap, to the ·0002 fixed "series aerial" condenser and to the "Out" socket on the five-socket base for the aerial combination arrangements.

"In" socket on same base to the remaining side of the ·0002 fixed condenser.

Sockets marked 10, 15 and 20 on the five-socket base to the corresponding sockets on the aerial-coil-holder base in the same compartment.

O.S. socket on aerial-coil-holder base to one side of the ·001 fixed condenser and to the fixed vanes of the aerial condenser (first section of gang).

Remaining side of the ·001 fixed condenser to the grid of V_1 and to one side of the 2-meg. grid-leak holder.

Other side of grid-leak holder to the lead for negative element (lead from zinc) of the first $1\frac{1}{2}$-volt "T" type cell.

"A" (anode) connection of V_1 to the O.P. socket on the first H.F. transformer base.

"G_2" connection of V_1 to the remaining side of the ·2-mfd. Mansbridge condenser nearest the variable condenser (in centre screened compartment), to the G_2 terminal on terminal strip, to the G_2 connection of V_2 and to the remaining side of the ·2-mfd. Mansbridge condenser nearest to the copper partition in the third screened compartment (near the H.T. fuse).

Grid of V_2 to one side of its ·001 fixed condenser and to one side of the 2-meg. grid-leak holder.

Other side of the ·001 to the O.S. socket on the first H.F. transformer base and to the fixed vanes of the second variable condenser (centre condenser of gang).

Remaining side of the 2-meg. grid-leak holder to the lead for negative element (lead from zinc) on the second $1\frac{1}{2}$-volt "T" type cell.

I.P. socket on the first H.F. transformer base to the remaining side of the remaining ·2-mfd. Mansbridge condenser in the second screened compartment, to the H.T.+1 terminal, to the I.P. socket of the second H.F. transformer base and to the remaining side of the remaining ·2-mfd. Mansbridge condenser in the third screened compartment.

"A" (anode) of V_2 to the O.P. socket on the second H.F. transformer base.

"R" terminal on same base to the moving vanes of the ·0001 variable reaction condenser. The lead passes through a hole in the last copper partition.

O.S. socket on the second H.F. transformer base to one side of the ·0003 fixed grid condenser and to the fixed vanes of the third variable condenser (last condenser of gang).

Remaining side of the ·0003 fixed grid condenser to the grid of V_3 and to one side of its 2-meg. grid-leak holder.

Other side of grid-leak holder to a plug via a short flexible lead.

Connections to the two-socket base for grid biasing of the detector.

"Grid Rectification" socket to the filament socket (+) of the detector valve holder joined to R_2.

"Anode-bend" socket to the G.B.−1 terminal on terminal strip. The plug connected to the grid-leak holder engages with one of the sockets according to the method of rectification required.

Plate of V_3 to one side of the ·0005 fixed condenser and to one side of the H.F. choke (the lead to the latter passes through a hole in the last copper partition).

Other side of the ·0005 fixed condenser to the fixed vanes of the ·0001 variable reaction condenser.

Remaining side of the H.F. choke to the "P" terminal on the R.C.C. unit.

"B+" terminal on same unit to the H.T.+2 terminal.

"C−" terminal on R.C.C. unit to the G.B.−2 terminal on the terminal strip.

"G" terminal on unit to the grid of V_4.

Plate of V_4 to the No. 3 terminal (primary) on the L.F. transformer and to one side of a second ·0005 fixed condenser (this condenser will be omitted with other makes of transformers).

Terminals 1 and 2 on transformer are joined together by a short-circuiting bar.

Remaining side of the second ·0005 fixed condenser to the No. 6 terminal on transformer (primary), to the remaining tag of the 2-mfd. Mansbridge condenser (which has its other connection taken to the L.S. terminal and copper), to the "H.T.+" terminal on the L.F. choke, and to the H.T.+3 terminal.

No. 5 terminal on the L.F. transformer to the G.B.−3 terminal on the terminal strip.

No. 4 terminal on transformer to the grid of V_5.

"Anode" terminal on the L.F. choke to the plate of V_5 and to one tag of the second 2-mfd. Mansbridge condenser.

Remaining tag of the condenser to the remaining L.S. terminal.

NOTE.—The G.B.+ lead for the L.F. (and detector if anode-bend rectification is employed) valves is common to the L.T.− terminal.

as a common connection for quite a number of circuits.

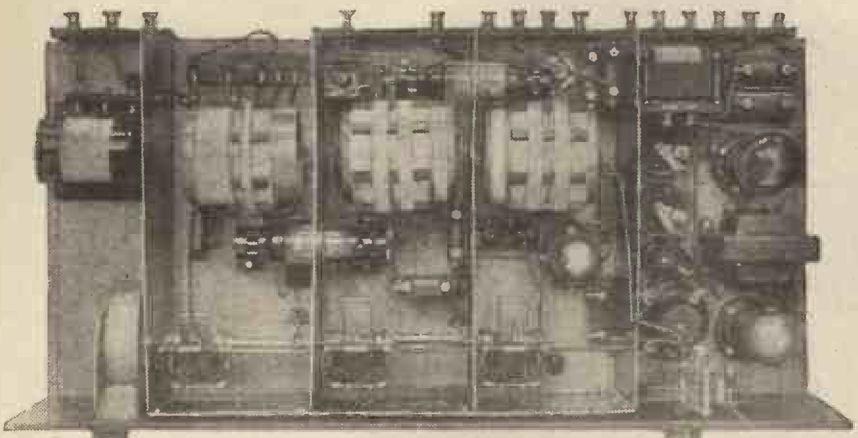
Thus, in the original set it was found convenient to connect the moving plates of each section of the gang condenser straight to the nearest point on the screens, and to connect the appropriate points on each coil base also to the screens.

By the way, on some gang condensers produced for this set you may find that the construction is such that all the moving plates are connected to the frame and so to the screens, so that one of the connections mentioned above, and shown on the blue print, is unnecessary.

Assembly

On the top of the copper sheet which covers the main baseboard, five dummy baseboards of wood, about ½ in. thick, are placed, for convenience and safety in mounting the various components. Each of these can be secured in place with a couple of screws passing down through holes drilled in the copper under-shield into the main baseboard, but it is not advisable to put these in until the set is nearly finished.

In certain instances, it should be observed, the condenser maker will be found to supply not merely the set of screens but also the various dummy baseboards, and in one special model which I have just seen (the Peto-Scott) matters are made still simpler for the constructor, for the whole assembly of condenser, screens, main baseboard and under-shield are made up as a complete unit ready screwed together and even fitted to the panel if desired, with the drum drive in place. (In addition to Messrs. Jackson Bros. and Peto-Scott, several other firms are understood to be producing a suitable condenser.)



A general view of the inside of the Solodyne showing how all the components and valves are arranged.

In practically every case it will be found that the screens supplied are provided with the necessary holes through which the H.F. valves will be mounted, but it may be as well to give the necessary dimensions for locating and drilling these. They are 1⅜ in. in diameter, and that for the first H.F. valve is located 6¾ in. from the rear of the set, that for the second being only 1⅝ in. from the rear edge.

One final point before we leave the assembly side of the constructional work and turn to matters of wiring: Certain gang condensers will be found to be provided with their own drum drive, instructions for mounting which will no doubt be supplied by the makers. Others may be fitted with the Silver-Marshall vernier drum drive (R. A. Rothermel, Ltd.), and this, again, is accompanied by fitting instructions. In most cases it will be found easiest to screw the bracket which carries this drive to the back of the panel, as was done in the original set.

Wiring

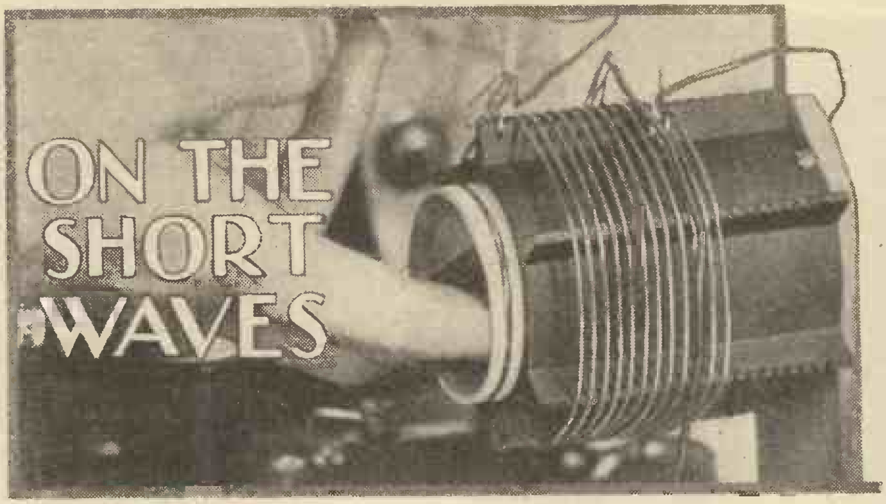
Wiring up is naturally a fairly big job in a set of this size, and it should be tackled in a methodical manner with the aid of the point-to-point connections list, which is really invaluable in this receiver, since it makes plain a number of points which it is impossible to render unmistakably clear on a blue print, which, of course, shows everything in one plane.

The material to be used in wiring is rather a matter of taste. The original receiver is wired with No. 18 tinned copper wire covered with Systoflex, and this is a good method. One of the specially prepared easy-soldering materials, such as Junit, could, of course, be used if desired.

If one of the covered wires, such as Glazite, is used it is wise to slip pieces of Systoflex sleeving over it where it passes through holes in the screens. These holes, by the by, should be drilled before you start to wire up, and they will be found quite easy to manage with the aid of a small hand drill, which can be held at an angle to reach the right spots.

(*Continued on page* 112.)

The complete receiver, showing the positions of the wave-trap, and the three tuning coils. The tuning control is on the left of the panel and consists of one knob which rotates a drum behind the panel.



It seems only a few months back (although in reality it must be about two years) when the ordinary broadcast listener regarded the short-wave "fan" as something of a crank, and regarded his tales of DX reception as mere fabrications. Now, however, I should imagine that about 20 per cent of broadcast listeners are placed in such a manner that they take *some* sort of interest in this branch of radio, whether they "go down there" on their ordinary receiver, have a special short-wave set, or merely share the pleasures of a friend in this direction.

Wonderful DX Results

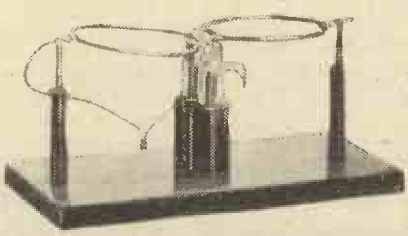
I propose in this short article to deal with the principal items of interest on the shorter waves at present, and it will be followed up with some hints and notes of readers' experiences, etc., together with notes of general interest to short-wave enthusiasts.

One only needs to use a short-wave set for a few weeks to find that one's entire conception of radio reception is changed. If on, say, 400 metres one were to hear a station just nicely filling the headphones with two valves in use, and, waiting for the announcement, to hear "this is station K D K A . . . ," the whole thing would strike one as wildly improbable, not to say impossible.

Reliable Stations

That is precisely how it strikes you when you first taste such real DX reception on the shorter waves, but after a while your thoughts on picking up the transmission will probably be "He's only about R7 to-night. I wonder what's the matter?" With such a widely different range of stations to listen to, and such a complete upsetting of one's idea of distance, on returning to the broadcast band one is apt to find things a trifle boring.

At present the main inducements to the average man to take up short-wave reception are undoubtedly the four or five high-powered American stations and the Australians, for there is no doubt that the reception of Australia is a "thrill" that compares with no other wireless achievement. 2 F C, Sydney, on about 28.5 metres, and 3 L O, Melbourne, on 32 metres, are Australia's representatives at present.



An experimental short-wave transmitter which works on a wave-length of about three metres.

The principal American stations are K D K A, in the region of 60 metres, 2 X A F (Schenectady) on 32·79 metres, and 2 X A D (Schenectady) on 21·5 metres. The two latter stations belong to the G.E.C. of America, and the former to the Westinghouse Corporation. These three stations are all easy to receive, and form a good "starting-off place."

Having started in the distance, we will now come nearer home. A powerful French station calling himself "Radio L L" has recently started transmitting on about 63 metres, incidentally making rather a nuisance of himself where K D K A was concerned at first, but the two stations are now a few degrees apart, and quite clear of each other. The French station, about which I have no definite information at the time of writing, is always received at good loud-speaker strength on two valves. He is, in fact, on occasions rather stronger than 2 L O at a distance of 6 miles.

The Nauen Group

A little lower down, at all times of day or night for about a week I could be certain of finding some enormously strong telephony, but as yet I have heard nothing more than "Achtung! Achtung! Hier der Sender A G J," repeated ad infinitum. A G J used to work on about 38 metres, and is, of course, one of the Nauen stations, but he is now on about 57 metres, and there is yet another branch of the Nauen tree on about 130 metres, sending A G K.

All the foregoing has dealt with short-wave broadcasting, but we must not forget that long before the broadcast stations commenced work on such short wave-lengths, these comparatively unexplored regions were thickly populated by the amateur transmitters or, as they prefer it, "hams."

Thousands of "Hams"

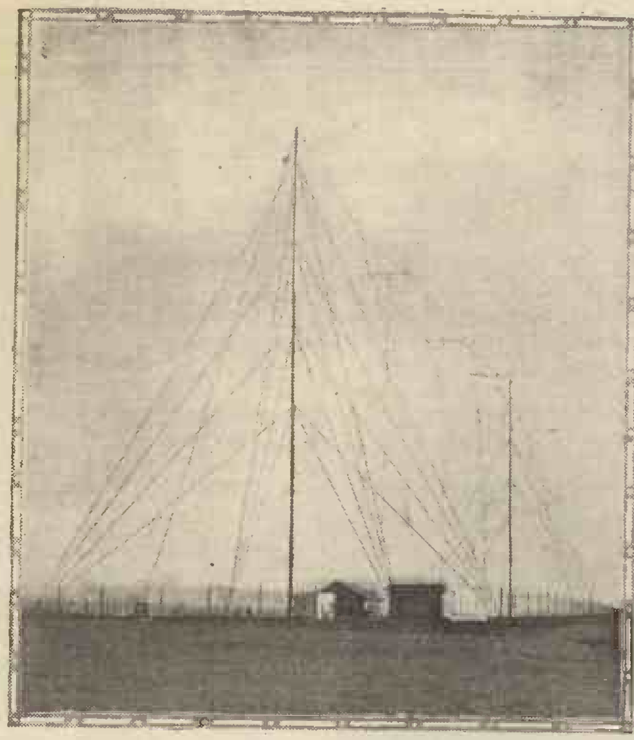
Strangely enough, most of the old familiar stations, the real pioneers, have now vanished from the ether, but there is no lack of others to carry on the tradition, and practically every country in the world now boasts its amateur experimenters. In the United States, I believe, they number about 36,000.

In this country, as represented by the T. and R. Section of the R.S.G.B., with a membership of some 1,400, there are probably 2,000 or more (some of whom, of course, are not yet allowed to radiate signals, but are allowed to experiment with transmitting apparatus and a "dummy aerial").

Learn the Morse Code

However, it is well worth while learning the Morse code and listening round occasionally between 20 and 50 metres; there are not many countries in the world that you will not hear during the twenty-four hours over this band of wave-lengths, and the amateur fraternity is a real "friendly society," which probably will do more to establish friendship between countries than any amount of mere correspondence could possibly do.

W. L. S.



PRAGUE CALLING!

Some interesting items about the famous Central European broadcasting station. From a Special Correspondent.

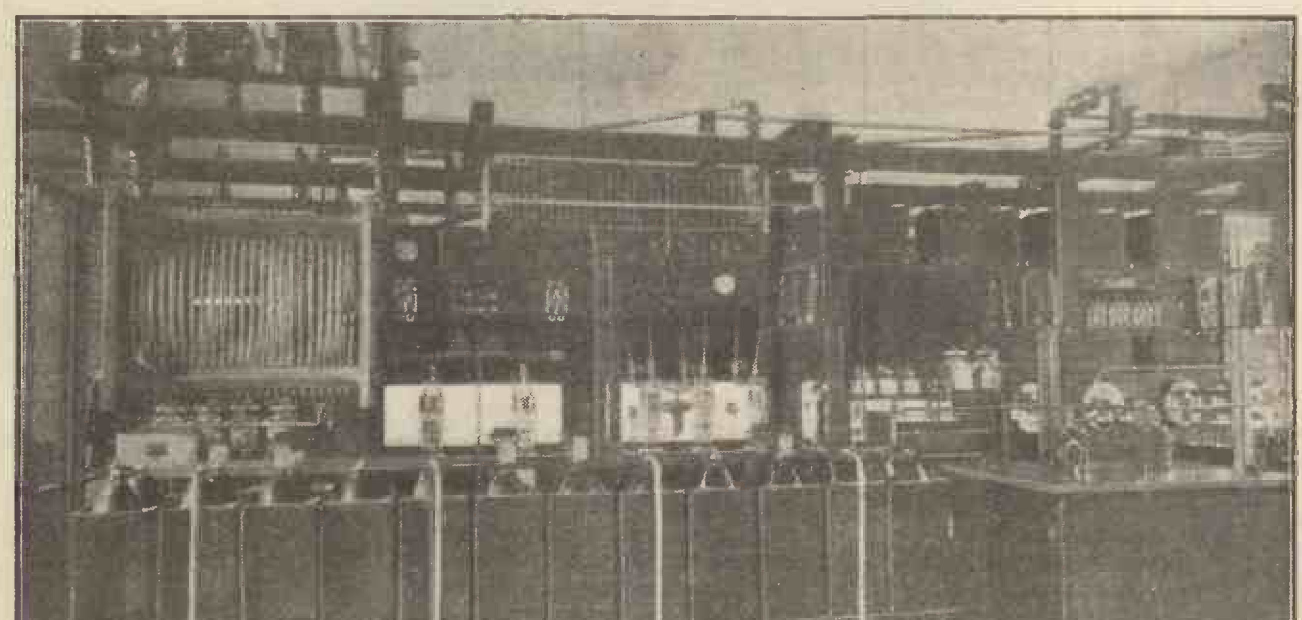
For some reason or other long-distance radio enthusiasts seldom go to many pains to pick up the programmes which are sent out nightly from the 5-kw. station at Prague, and on account of this fact we in England know little or nothing concerning this very interesting centre of broadcasting and its manifold activities.

Situated in the heart of Czecho-Slovakia, the Prague broadcasting station—a station which is certainly no dwarf amid the radio centres of Europe—endeavours to cater adequately for a community which is considerably varied in nature. Commencing daily at 11 a.m., the station transmits at intervals a programme of the usual type, closing down generally at 10.30 p.m. each night.

Special Musical Appeal

Given a reasonably efficient set, therefore, there is no reason why this European station should not be heard, at least on occasions, by listeners in this country. The wave-length of the station is 348.9 metres, which, expressed in the newly-adopted notation, is equivalent to a frequency of 859 kilocycles.

The Prague station sends out the usual talks, news bulletins, and items of local interest which are, of course, to be inevitably associated with every active broadcasting centre. Apart from these, however, Prague specialises in its musical programmes. To this end, the station maintains a normal orchestra of twenty-five trained musicians, an orchestra which is frequently augmented by other instrumentalists for the performance of special

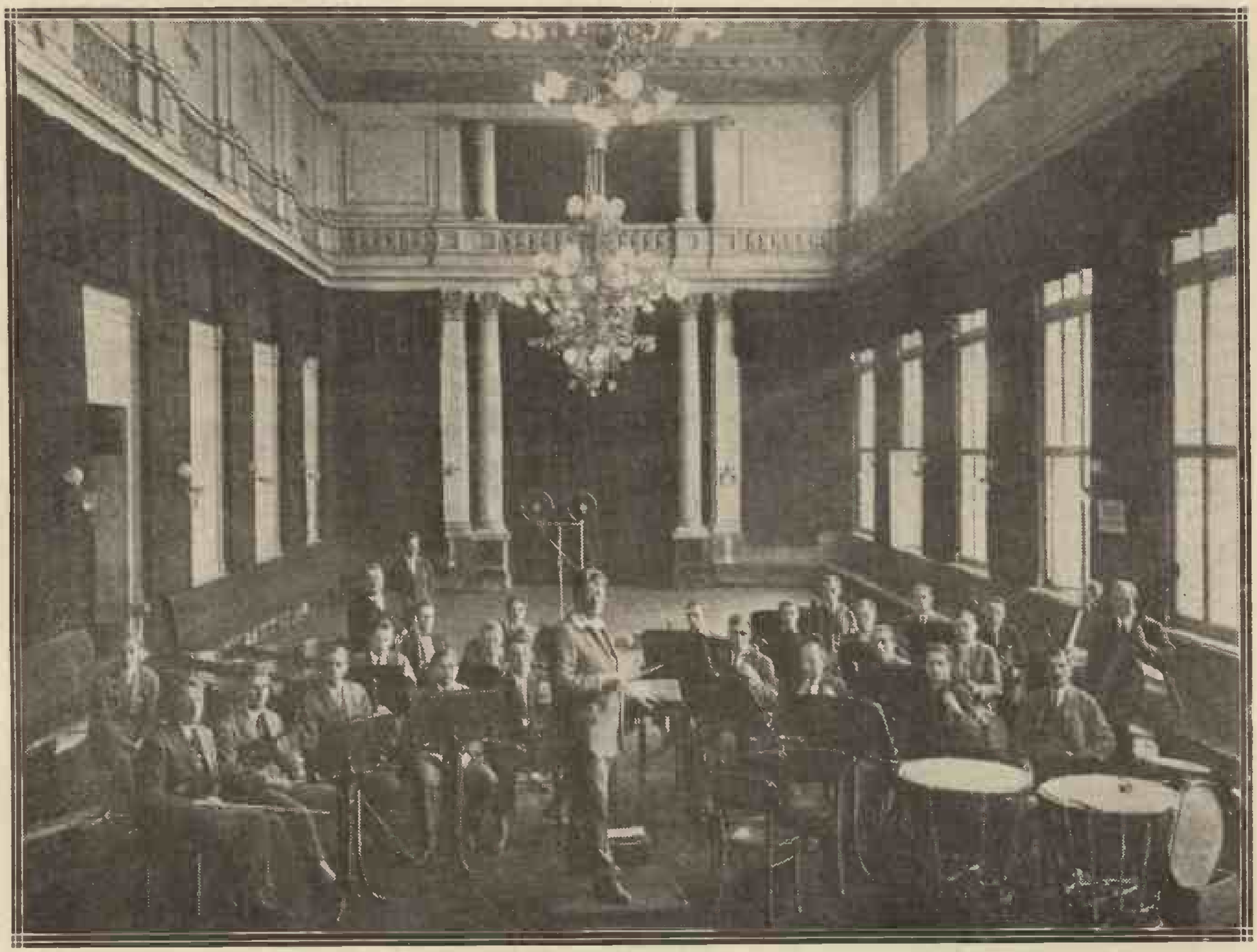


A view from behind the large Prague transmitter which has a power of five kilowatts.

works. The station possesses its own string quartet which performs daily, generally in the afternoons.

From a purely technical point of view, the 5-kw. station at Prague is quite a normally equipped and constituted one. However, for the interest of amateurs who have managed to pick up the station, a few descriptive notes concerning it will not be amiss.

Two studios are available at Prague, a small one for the broadcasting of talks, solo items, and small instrumental combinations, and a large one for the transmission of orchestral works. The studios are situated parallel to each other, and between the two is placed a small control room, containing amongst other things a panel which is equipped with all the studio control and switching arrangements, auxiliary controls to the main transmitter, and also a relay and simultaneous broadcasting board, by means of which the station is connected up to the associated Czecho-Slovakian stations at Bruenn, Bratislava, and elsewhere. Situated in the studio control room, also, is a control receiver by means of which the programmes which are sent out are picked up on a small aerial.



The large studio at Prague, with the station orchestra of twenty-five performers.

The Transmitter

Thus a strict control on the quality of the transmissions is exerted. This control receiving set is wired up to loud speakers in the station's reception room in order that artistes and visitors to the station may be suitably entertained.

Concerning the transmitting apparatus proper, there is little of any special interest to be said about it. The majority of the apparatus is of Western Electric design and construction, although some of the refinements connected with its working are of local manufacture. The main 5-kw. transmitter contains six separate panels which embody the valve oscillating, modulating, and amplifying units, the aerial tuning condensers and inductances, controls from the studios, etc., and a meter panel.

Early "On the Air"

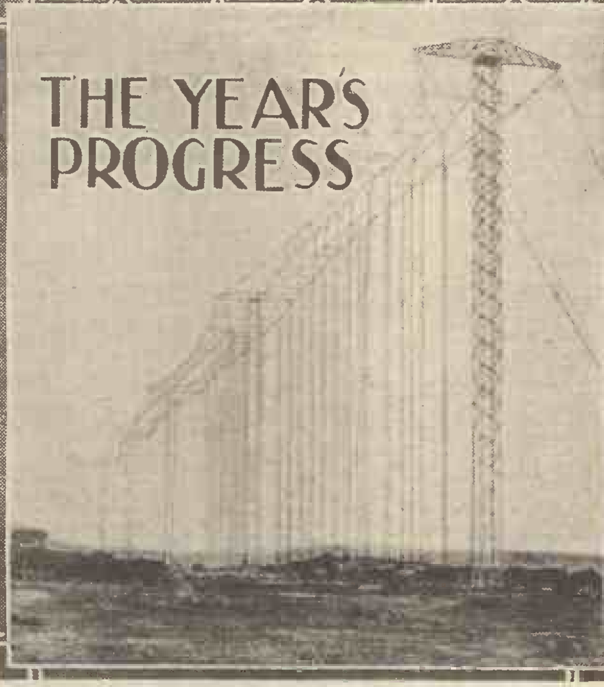
The station has its own power-house from which the required H.T. and L.T. current is derived, but it can also take a portion of its current from the local mains. A small emergency generating set of the petrol motor type is also maintained in the station power-house.

Coming now to the aerial of the station, this is situated high above the outskirts of the town, and is connected by land-line with the studios and transmitting room. The aerial system takes the form of two 200-ft. steel masts of the tubular type, separated from each other at a distance of 190 ft., the "active" portion of the aerial consisting of three 150-ft. strands of wire in parallel.

Such, in brief outline, is the constitution and equipment of one of the most interesting of the European broadcasting stations, of one of the oldest of the European stations in fact, for the Prague station was "on the air" as early as the year 1922. Since that time, of course, it has been completely redesigned and re-erected in accordance with the most up-to-date ideas.

Radio Developments of 1927

A thoughtful survey of recent achievements.
By J. C. JEVONS.



ALTHOUGH problems relating to reception are naturally of more interest to the ordinary listener than those relating to transmission, it is necessary to take both these aspects into account when dealing with the progress made by radio science as a whole.

Improved methods of transmission bring in their train corresponding advantages to the listener, either in the way of securing a higher standard of reproduction, or a greater freedom from undesirable interference, or else of developing new possibilities in long-range working.

For instance, one outstanding achievement during the last few months has been the completion of the Empire scheme of Beam wireless. The results secured by the use of the ingenious Franklin aerial and reflector in confining short-wave signalling energy into a comparatively narrow path over very long distances points to the possible application of similar methods to the broadcast service.

Fading and Empire Broadcasting

In the first place, it would be possible by Beam transmission to distribute different programmes along selected zones of territory with the minimum of overlap. In the second place, the same system offers a practical solution to the problem of relaying foreign or Colonial programmes over long distances through the ether with a minimum of atmospheric disturbances, where a connecting wire or trunk line is not available.

It has been argued that the time is not yet ripe for Empire broadcasting, because of the difficulty in maintaining a reliable standard of transmission and reception on the short wave-lengths that it is necessary to use for such long-distance work. The chief difficulty here is due to fading, and it may be of interest to mention some of the investigations that are being carried out with the object of overcoming this defect.

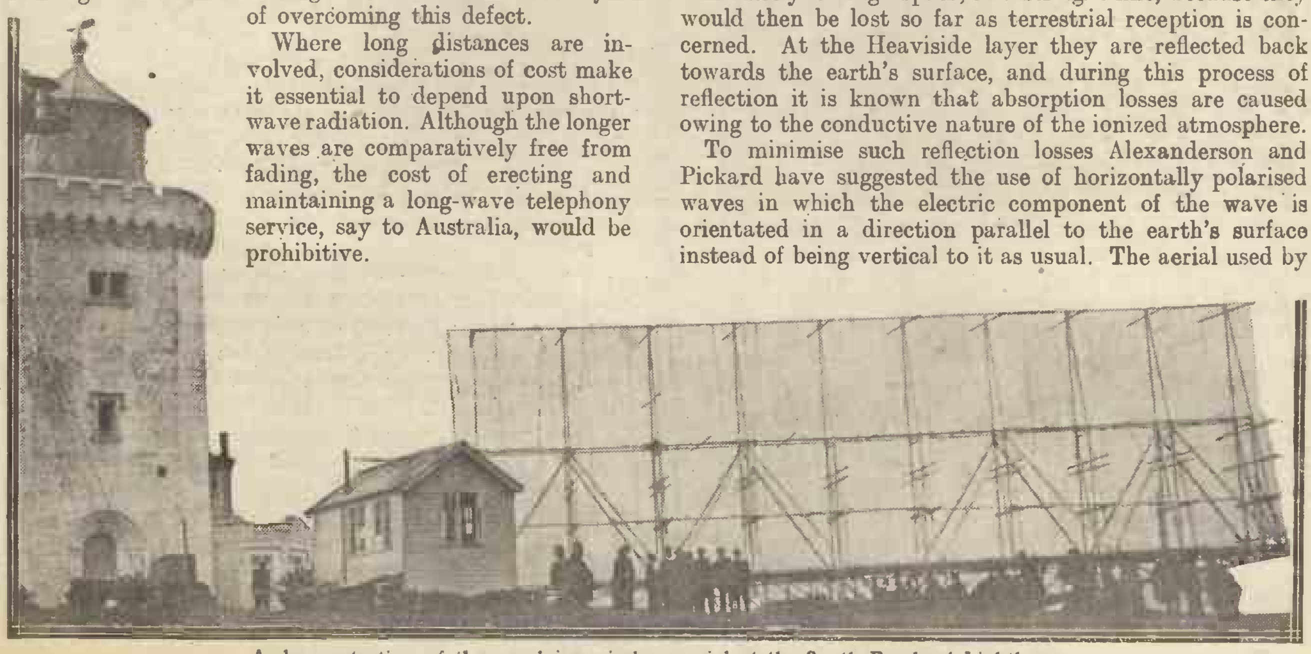
Where long distances are involved, considerations of cost make it essential to depend upon short-wave radiation. Although the longer waves are comparatively free from fading, the cost of erecting and maintaining a long-wave telephony service, say to Australia, would be prohibitive.

The reason why short waves, of comparatively low power, are able to traverse enormous distances, is due to the fact that they travel through space, whereas long-wave energy is more or less conducted from point to point along the earth's surface. Such waves are dissipated or attenuated by resistance losses caused by the earth's conductivity, whilst the shorter space waves travel free from this particular source of loss.

Plane-Polarised Radiation

On the other hand "space waves" encounter difficulties which are peculiarly their own. They cannot travel indefinitely through space, in a straight line, because they would then be lost so far as terrestrial reception is concerned. At the Heaviside layer they are reflected back towards the earth's surface, and during this process of reflection it is known that absorption losses are caused owing to the conductive nature of the ionized atmosphere.

To minimise such reflection losses Alexanderson and Pickard have suggested the use of horizontally polarised waves in which the electric component of the wave is orientated in a direction parallel to the earth's surface instead of being vertical to it as usual. The aerial used by



A demonstration of the revolving wireless aerial at the South Foreland Lighthouse.

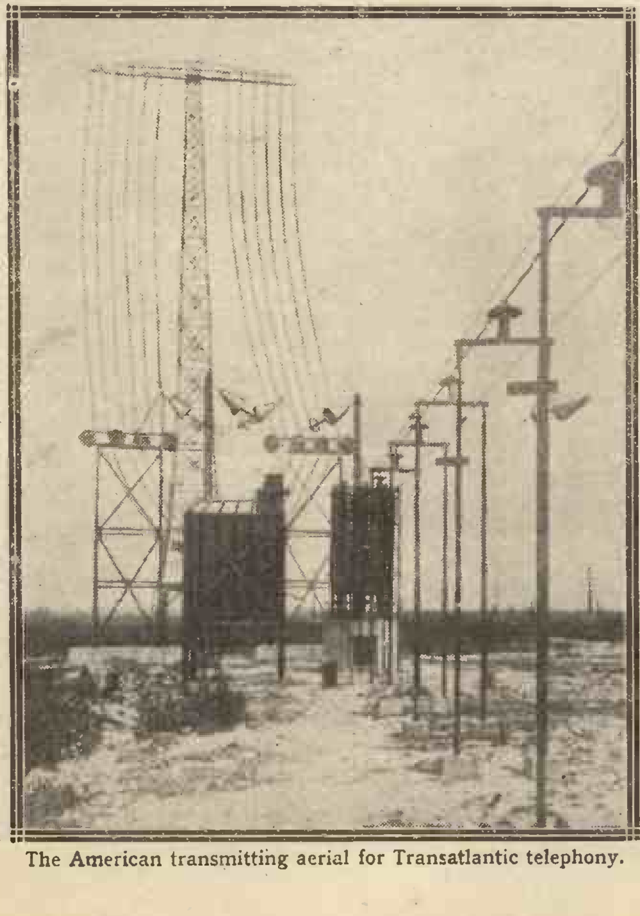
Alexanderson for this type of radiation comprises a large loop suspended by masts so that its plane is parallel to the ground. It is found that signals sent in this way can be received free from fading fluctuations at distances of over 1,000 miles from the point of transmission.

The German Telefunken Co. have also suggested the employment of circularly polarised waves for the same purpose. They use two short-wave Hertzian oscillators mounted horizontally above the ground and fed separately from the power house with oscillations which are relatively ninety degrees out of phase. Under these circumstances the radiated wave has a rotary electric field, instead of vibrating either in the vertical or horizontal plane.

Stereophonic and Echo Effects

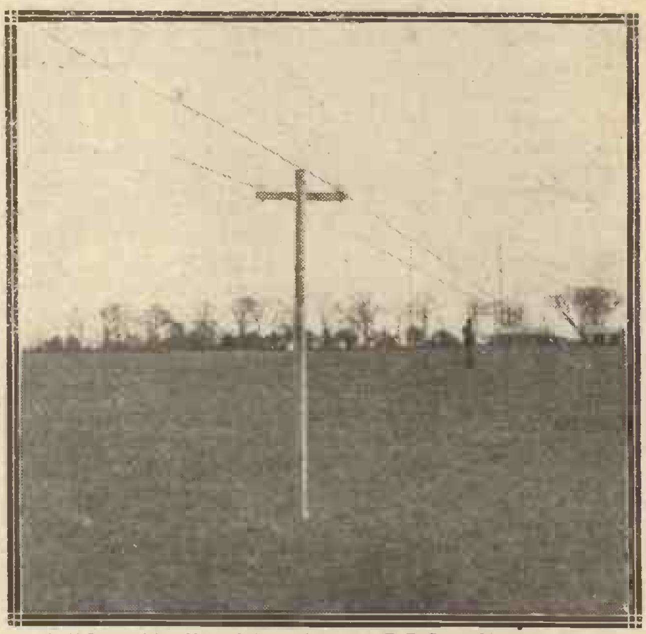
It is then found that whatever reflection losses do occur at the Heaviside layer are uniform and not irregular in character, so that the strength of the signals received does not fluctuate in the irritative fashion so characteristic of ordinary fading. As regards the technique of broadcast transmission, experiments are still being made with the object of imparting the so-called stereophonic effect to the radiated signals. However, the practical difficulty remains that such transmission requires two separate carrier waves for each programme instead of one. In the present state of ether congestion it is therefore hardly likely that stereophonic broadcasting will come into extensive use.

Considerable interest has also been aroused by the new scheme devised by Captain Round for improving the acoustic properties of the transmitting studio by means of artificial echo effects. With this object in view the microphone in the studio is connected to an auxiliary loud speaker located in a separate room designed to have special resonating properties.



The American transmitting aerial for Transatlantic telephony.

A second microphone is arranged to pick up the reproduction from the auxiliary loud speaker, together with a certain mixture of "echo" or resonance effect due to the acoustics of the special room. The resulting "mixed"



A "Beveridge" aerial used by the B.B.C at Keston, Kent.

current is then fed to the modulator in parallel with the primary current from the original studio microphone. The resulting quality of the signal is improved by the added resonance effects and a better tone balance or timbre is produced at the receiving end.

Interference due to atmospherics and to overlapping programmes is an admitted bugbear of modern broadcasting. To some extent a remedy may be found by improving the selectivity of the receiving circuits, but it is doubtful whether this alone will ever solve the problem completely. Recently attempts have been made to tackle the question from the transmitting end.

Suppose, for example, that a programme is broadcast on two different wave-lengths instead of one, and that two correspondingly tuned circuits are used at the receiving end. It can easily be arranged that any tuned interference, such as an overlapping programme, can be made to affect one of the receiving circuits either exclusively or to a far greater extent than the other.

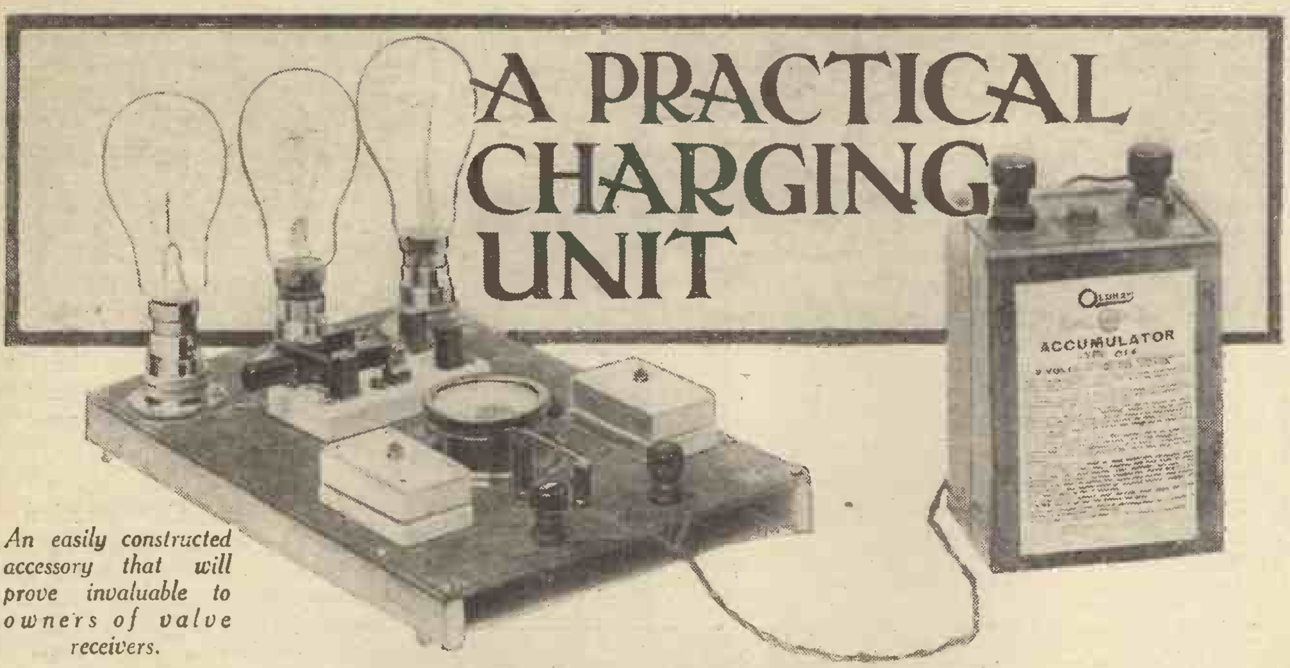
Eliminating Interference

After detection, therefore, one of the receiving circuits will contain the pure signal, whilst the other will contain a mixture of the signal and interference. By opposing these two components, the interference component can be isolated, whilst by adding the two components, one can obtain a double-strength of pure signal mixed with interference. Finally, by balancing the results of the first and second operation one is left with a double-strength of the desired signal free from any trace of interference.

The use of two carrier frequencies is an admitted drawback, but this could be met by a reduction in the number of stations at present in operation. The same system of balanced reception is also applicable to the elimination of atmospheric disturbance, as well as to the minimising of Morse interference. Although the method may appear somewhat complicated in theory, it can be carried into effect by a simple receiving installation.

(*Continued on page* 108.)

A PRACTICAL CHARGING UNIT

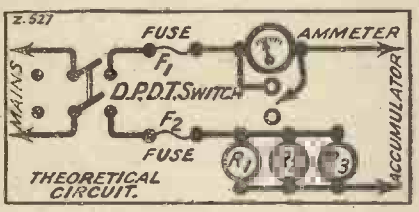


An easily constructed accessory that will prove invaluable to owners of valve receivers.

By J. R. WHEATLEY.

Generally speaking, there are three types of batteries used in connection with radio sets, one of them being the L.T. battery, and in this article we will deal with that source of current alone.

Every set in general use to-day employing valves for the reception of radio programmes uses an L.T. supply, u-ually in the form of a battery, to light the filaments of the valves. This is its one and only function, but if it does not perform this properly the action of the entire set is spoiled. As is well known, in order to make a valve operate—that is, the type of valve that is in general use—it is necessary that a very thin wire, sealed within the valve, be heated to incandescence, and this is accomplished by passing a current of electricity through it. The L.T. battery furnishes this current and so enables the valve to operate.



Storage Batteries

When electricity is fed into an L.T. battery (sometimes called the "accumulator" or storage battery) a chemical change takes place within it. This chemical change is of such a nature that when the two terminals of the battery are connected to an external circuit through which current can flow, a reverse chemical action takes place and a current of electricity is generated.

It is quite essential that a storage battery be chosen which is designed for the type of the work which is encountered in radio reception; or, in other words, the battery selected should be one that gives good service when used at a slow discharge rate.

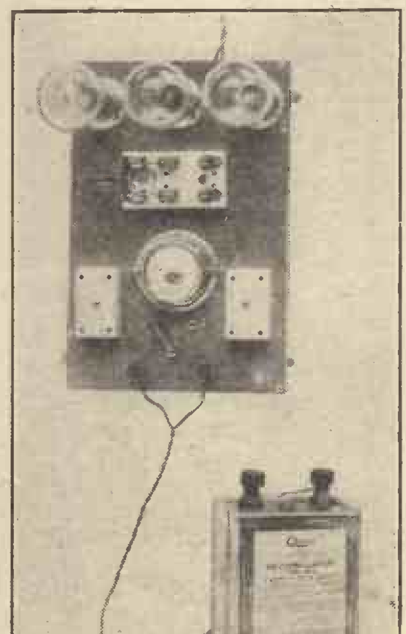
At the present time the writer is using a standard type of accumulator which has been employed for operating various radio sets for a period of almost four years; the battery is still giving excellent service, and, in fact, does not show any sign of deterioration. This sort of service can only be obtained by proper care of the battery.

The Home-Charger

From the mention made of the chemical action taking place within a storage battery it is quite obvious that some sort of arrangement must be used for introducing current into the battery so that the chemical change will take place, and so that the battery can later, after it is charged, be used for operating a wireless set. Furthermore, there is one point that must be stressed here, and that is that the current introduced into a storage battery when charging it must be of the same general type as the current to be delivered from the battery; in other words, direct current must be used.

The particular unit about to be described enables an accumulator to be kept in proper condition. By means of a very simple arrangement it allows accumulators to be charged from the direct-current lighting or power mains without the addition of any complicated apparatus.

The panel to be used is made from an ordinary blue roof slate. When obtaining this slate from a local builder examine it carefully and choose one which is comparatively



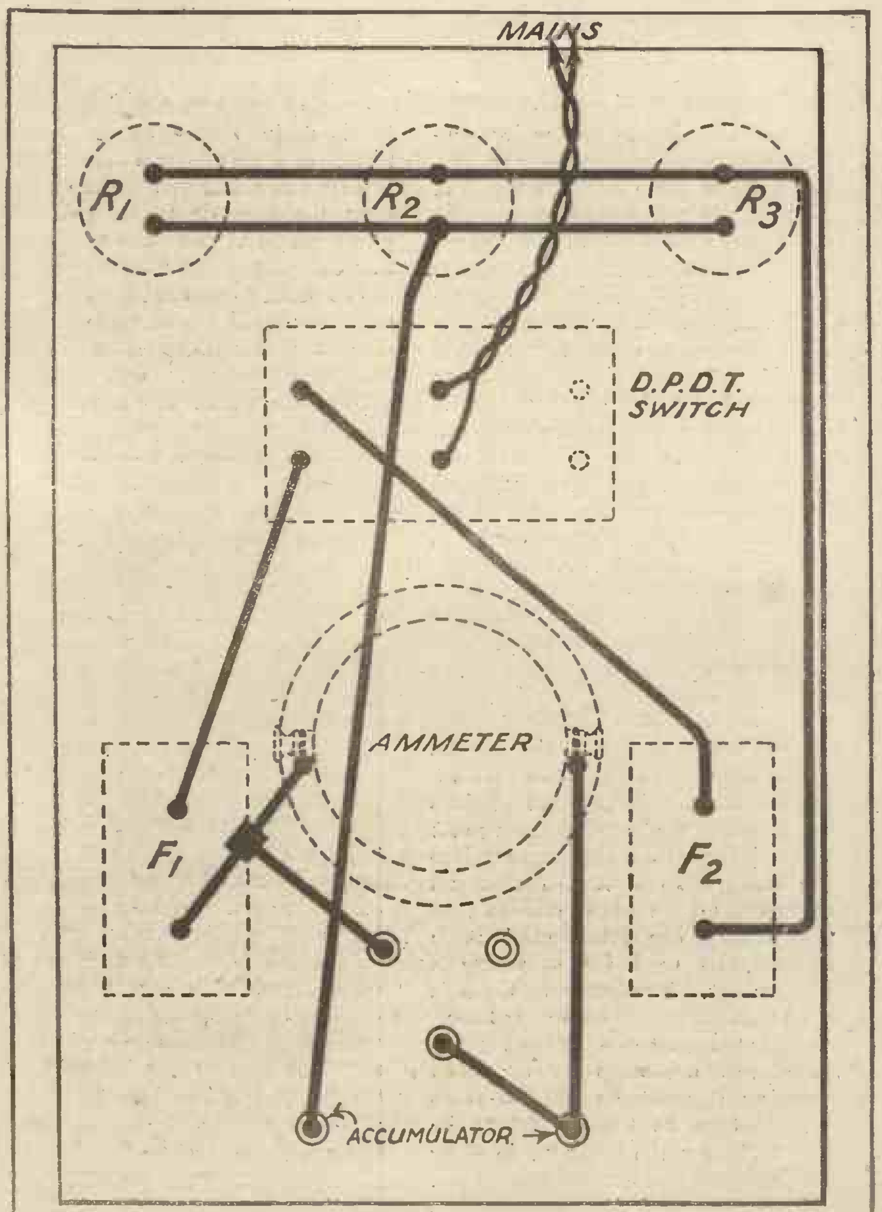
The charging board fixed up ready for switching on, showing the connections to the accumulator free from the various minerals usually found in slate. Choose the smoothest section, and mark out a piece 8 in. by 12 in. with a sharp-pointed instrument such as a scriber. With the aid of a hacksaw it is possible to cut the slate without any fear of cracking or splitting. Do not forget, however, to keep the panel quite flat. Smooth up the edges with the aid of a rough file, and the slate is ready for polishing (the reason will now be seen why a smooth slate should be chosen).

Polishing the Slate

Procure one of the softer types of bricks which are used for facing buildings and carefully rub the surface of the slate; the addition of water assists in this operation. When the slate appears to be fairly smooth, obtain some pumice stone and finish off the surface. The panel should now be thoroughly washed and carefully dried. When the exact positions of the various components have been decided upon, the holes to be drilled should be centre-punched and drilled through by means of an ordinary twist drill.

The mounting of the small Eelex sockets should be carried out first. By moving the centre plug so as to connect up the left-hand socket the ammeter is placed in circuit, and measures the current flowing. When, however, it is placed in the right-hand socket the ammeter is shorted. The actual charging rates possible with this board vary between a fraction of an ampere and approximately three amperes, so that an ordinary ammeter (this need not be of the expensive type) reading up to three amperes will be quite O.K.

After mounting the ammeter, mount the small oblong "cut-outs." These carry the fuses, and more about their actual size will be said later. An ordinary D.P.D.T. switch of the type usually employed for earthing the aerial is used to connect the mains to the charging board. The three lampholders are of the standard "batten" type, and should not be placed too close together, or it will be found impossible to place all three lamps on the board at once.



WIRING DIAGRAM.

Completing Construction

The accumulator terminals need only be of ordinary W.O. type, although the board looks far more businesslike if large insulated terminals such as those manufactured by Belling & Lee are used. The actual wiring of the set is simplicity itself, and is best carried out with stiff insulated wire such as Glazite. All connections should be soldered, except, of course, where they are joined to the lamp sockets, etc. When installing our charging board the panel must be mounted in a position so that it is quite close to the mains socket, but well away from any place where the presence of an accumulator "gassing" might cause damage.

LIST OF COMPONENTS.

- 1 slate panel, 8 in. × 12 in.
- 3 batten holders.
- 1 D.P.D.T. switch.
- 2 oblong cut-outs.
- 3 Eelex sockets.
- 2 Eelex plugs.
- 1 3-amp. ammeter.
- 2 insulated terminals.
- Glazite.

Total cost approx. £1 1s. 0d.

Two flexible leads are brought from the mains and connected through the back of the panel to the centre contacts of the D.P.D.T. switch. Two small strips of wood screwed to the back of the panel (see photographs) keep the wiring away from the wall. Obtain four small flat plates as used for mounting cupboards to walls, etc., and screw to the edges of the two strips of wood.

Our panel is now ready for connecting to the mains. Place an electric bulb of the same voltage as the mains in one of the lamp sockets and join a 5-amp. fuse in each of the "cut-outs." (5-amp. fuse wire is obtainable from any electrician's

	CARBON LAMPS.				METAL LAMPS.			
Mains Voltage	25-v.	50-v.	100–120-v.	200–230-v.	25-v.	50-v.	100–120-v.	200–230-v.
·25 amp.	—	—	8 c.p. (28-w.)	16 c.p. (56-w.)	—	15-w.	25-w.	50-w.
·5 amp.	—	8 c.p. (28-w.)	16 c.p. (56-w.)	32 c.p. (112-w.)	—	25-w.	50-w.	100-w.
1·0 amp.	6 c.p. (21-w.)	16 c.p. (56-w.)	32 c.p. (112-w.)	60 c.p. (224-w.)	25-w.	60-w.	100-w.	200-w.

Note.—The figures in brackets (i.e.—56 w.) indicate the equivalent wattage of the lamp as against the candle-power given.

shop.) Now short the two accumulator terminals with a piece of wire. Connect the remaining ends of the flexible lead to a suitable adapter and join to the mains.

If the switch is closed on the panel the lamp should light, showing that the panel is connected correctly to the mains. Switch off the mains by placing the D.P.D.T. switch in the opposite direction, and remove the shorting wire across the accumulator terminals. Two pieces of copper wire are then joined to the accumulator terminals and the ends of these wires placed about one inch apart in a glass of salt water.

WIRING CONNECTIONS.

Two leads from mains to centre contacts of D.P.D.T. switch.

Left-hand bottom contact of switch to one side of F_1. Remaining side of F_1 to one side of ammeter and left-hand top socket on panel.

Other side of ammeter to right-hand accumulator terminal and bottom centre socket.

Left-hand accumulator terminal to one side of R_2, R_1 and R_3.

Remaining sides of R_1, R_2 and R_3 to one side of F_2.

Other side of F_2 to top left-hand contact of D.P.D.T. switch.

If the switch is now placed in the "on" position the lamp will light and bubbles will be seen to come from the ends of the wires in the glass. One, however, will bubble more than the other; this is the negative main. The terminal on the panel to which this lead is connected should be clearly marked negative. (A further test may be made by sticking the two ends into a freshly cut potato; the *positive* main will then leave a greenish stain.) The adapter and socket making the mains' connection should be marked so that these will always be connected in the same way when connecting up the charging board.

This board will enable a 2-volt or a 100-volt accumulator to be charged from a fraction of an ampere up to three amperes. By inserting a suitable lamp or lamps in the socket or sockets provided on the panel a variety of charging rates is made possible. The table above gives suitable lamps for charging accumulators from two to twelve volts.

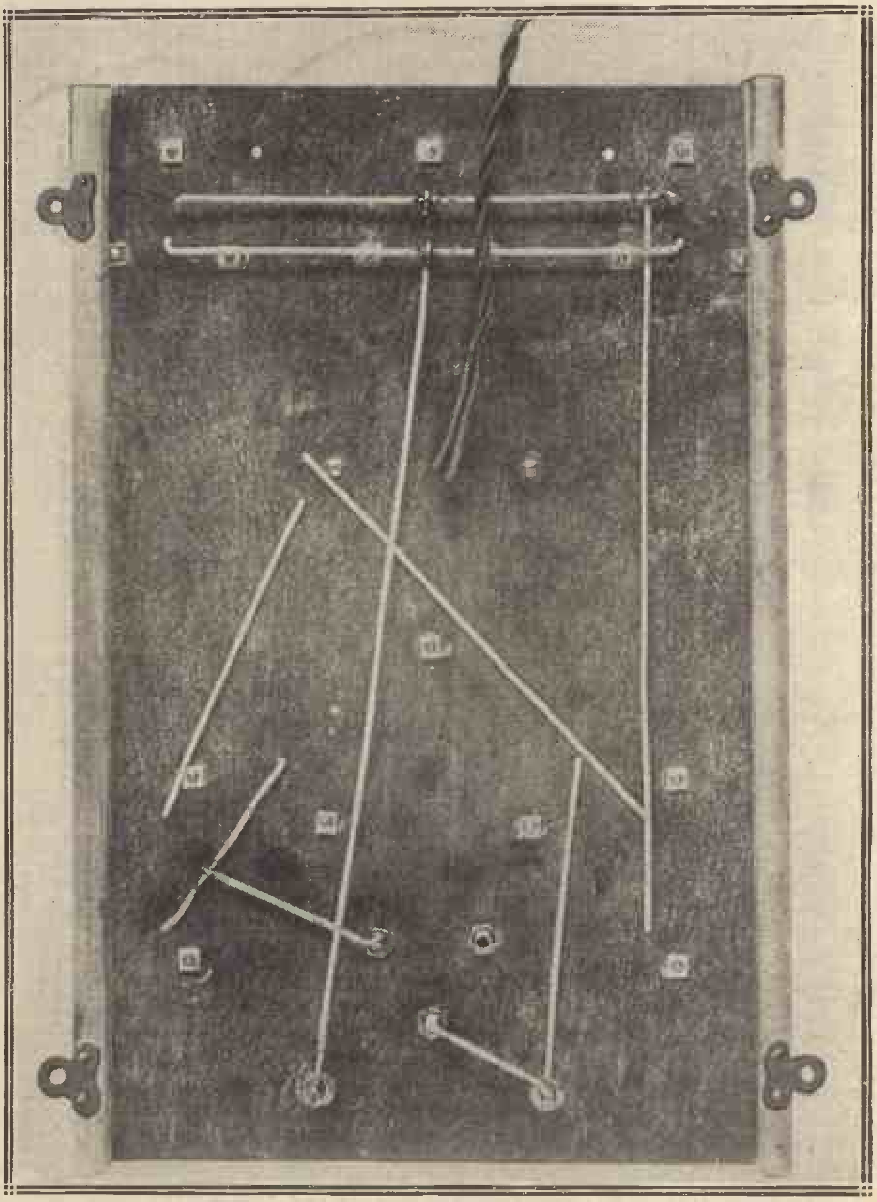
We will assume that a 2-volt 30-amp.-hour accumulator is to be charged, and our mains are 200 volts. After examining the makers' instructions we will probably find that a normal charging rate of 2·5 amps. is given. On looking at the table we find that a 200 v., 60 c.p. carbon lamp gives a charging rate of 1 amp. If, therefore, we place two of these lamps in the holders the charging rate is 2 amps.

Further Details

By shorting the accumulator terminals and closing the switch on the panel the ammeter will verify this. The addition of a third lamp, 200 v., 32 c.p. carbon, placed in the third holder allows a further ·5 amp to flow, and our charging rate rises to 2·5 amps.

The accumulator should now be connected to the terminals on the

(*Continued on page* 107.)



The under-panel wiring is carried out with insulated wire as shown in this photograph. The flex lead is connected to the switch, as will be seen in the wiring diagram.

Questions Answered

A Rectification Problem

S. E. (Cheltenham).—" In view of the fact that the majority of long-distance receivers employ leaky-grid-condenser rectifiers, I am interested in a statement made by a well-known writer, '. . . that in the case of a leaky-grid detector, we have to be very careful that we do not materially lower the amplification and spoil the selectivity.'

" Is it true to assume, then, that an anode-rectifier may give greater sensitivity than that obtained from the use of the more popular grid-leak-and-condenser method? Since I have always understood that the latter was superior for long-distance reception?"

The answer to this depends almost entirely upon the design of the H.F. circuits. If no reaction is employed and the tuned circuit preceding the detector valve is designed to have very low damping, as might be the case if highly efficient Litz-wire coils were used, then it is quite possible that the effect of a grid-leak condenser rectifier would decrease both amplification and selectivity. The H.F. magnification and selectivity are, of course, a function of the circuit damping, and from this point of view it naturally pays to keep this factor low.

Damping

Although a leaky-grid-condenser rectifier normally tends to give greater sensitiveness, its effect on a tuned circuit, assuming the grid leak to be taken to positive filament, might be such as to increase the circuit damping very considerably, thereby lowering the overall amplification to several degrees below that obtained from a similar circuit followed by an anode rectifier.

This low damping, has its disadvantages, since quality may suffer.

The use of, say, three very low-resistance tuned circuits, as would be the case with a long-distance receiver, frequently has a detrimental result upon the reproduction of the higher musical frequencies, and the signals may become woolly and muffled, especially if the low-frequency stages exhibit the same tendencies. This tends to offset the advantages of an anode rectifier from the quality point of view.

For this reason, set designers often prefer to use H.F. circuits of moderately low-resistance in conjunction with a grid-leak rectifier and reaction, the reaction compensating for the increase in damping due to the method of rectification employed. In this way good quality can be maintained from the nearer stations, whilst reaction can be used to boost up the more distant ones, and to improve the tuning.

You will understand that the design of long-distance sets with a limited number of valves is more or less a matter of compromise, and it is not yet possible to produce a receiver with two or three tuned circuits to give perfect quality and really high amplification coupled with maximum selectivity. Such a set would be far too expensive for the average listener to build. The design of a receiver purely for the local station is, of course, a very different matter. The "Super Screen" Four is a good example of a set designed to give good quality and reasonable long-distance results.

C.F.C.'s Circuit

J. R. (Glasgow).—Asks whether in the circuit shown on page 452 of the November issue the loud speaker should not have been connected across the secondary winding of the output transformer.

Yes, the loud speaker should be joined across the output terminals of the transformer in the anode circuit of the last valve. The two terminals marked L.S. were to enable a milliammeter to be placed in series with the last valve for the purpose of checking quality, and the condenser shown across these terminals is merely a by-pass capacity across the milliammeter. The letters L.S. should therefore read M/A.

Adding H.F. to Super-Het.

L. A. (Norwich).—" I wish to increase the sensitivity and selectivity of my super-heterodyne receiver. Is it possible to add an H.F. stage in front of the first detector?"

You could add a screened H.F. stage fairly easily. By employing one of the new-type cube screens you would be able to place a standard split-primary transformer together with the H.F. valve and neutralising condenser inside the metal box. It would be a good plan to erect a static screen between the H.F. and frame tuning condenser, but if you cared to experiment a little you could "gang" these two condensers together, thus retaining only two tuning controls. A screened H.F. stage is essential, otherwise it would be impossible to stabilise the receiver. Every adjustment of the frame would tend to upset the neutralising if an unshielded H.F. transformer was used.

The increase in sensitivity resulting from the use of an H.F. valve working at the fundamental frequency is very marked and it has the advantage that it assists in the elimination of "second channel" interference.

MIXING STUDIOS

An article explaining how the different effects and studios are faded-in and out, so that the broadcast "pictures" are pleasingly presented in one continuous programme.

By BAYNHAM HONRI

COMPARISONS are decidedly not odious. It is essential that one should compare one thing with another thing of the same kind before it is possible to form a true judgment of the merits of either. There may be some people who prefer the "familiar" methods of American announcers to the more formal speeches of British announcers. (Personally, I'd soon get tired of "Howdy, folks! You're sure goin' to like this little toon, played by —— ".) Going a stage farther, it is possible to compare the straight "concert" broadcasting programmes of one country with another and form an opinion. But when we get to plays and what might be termed "presentation" programmes, there can be no comparison. Largely owing to a technical development the British stations have the field to themselves in this department.

Early Methods

In the early days of broadcasting it was customary for the announcer to make the microphone "live" by closing a switch on the microphone stand. This made a terrific "clunk" —rather like the sound of a gas-cooker oven being closed—and it was quickly realised that this was not very "artistic." The control potentiometers on the amplifiers were altered so that they would give a complete "fade out" when turned fully anti-clockwise. A natural development of this was the "dissolve," the broadcasting equivalent of the "lap-dissolve" of the cinema film.

As one studio was faded out, another (or an outside broadcast) would be faded in, the outputs of the controlling amplifiers being in parallel during the actual dissolve. Later, a semi-automatic device was developed (see Fig. 1), in which one knob controlled the simultaneous fading in and fading out of two studios on one amplifier. This enabled the whole operation of dissolving or superimposing to be done by one control engineer instead of three, as had previously been necessary. Special "shows" involving the use of three or more studios were (and are) taken through a special control board.

This may seem to have little to do with "presentation" programmes or plays. Cinema-goers have gradually become accustomed to the technique

This large studio in Broad Street, Birmingham, has an area of 2,000 square ft.

of the film—the "close-up," "long shots," "superimposed titles," "double exposures," etc., though they may not recognise the technical names. The excellence of the average modern film is largely dependent on this technique, because writers of film stories and scenarios have come to realise its dramatic possibilities.

The Personal Touch

The same thing has been happening in broadcasting—in this country, at any rate. The broadcast play lacks the personal touch, the scenery, and other accessories of the theatre, and it has to make up for this by the intelligent use of broadcasting technique for the creation of suitable "atmosphere."

The stage play usually consists of three or four acts, each act (or scene) being a separate "slice" of the story, without any breaks or interruption to denote the passing of time. The cinema play requires entirely different methods. The number of scenes is no longer limited to three or four, by technical tricks it is possible to concentrate attention on situations, persons or objects, and the passing of time is conveyed by "fade-outs." The film must be dependent more on action than words; indeed, lack of sub-titles is considered to be a virtue. Suitable accompanying music adds enormously to the "atmosphere."

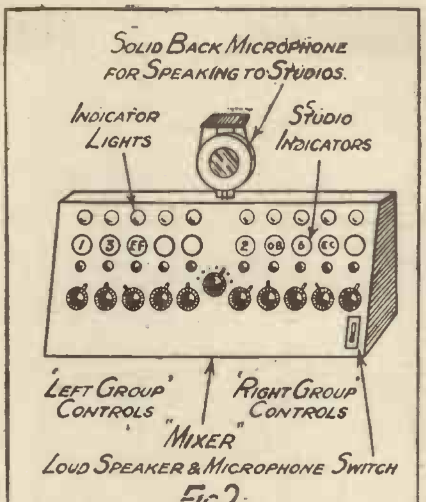
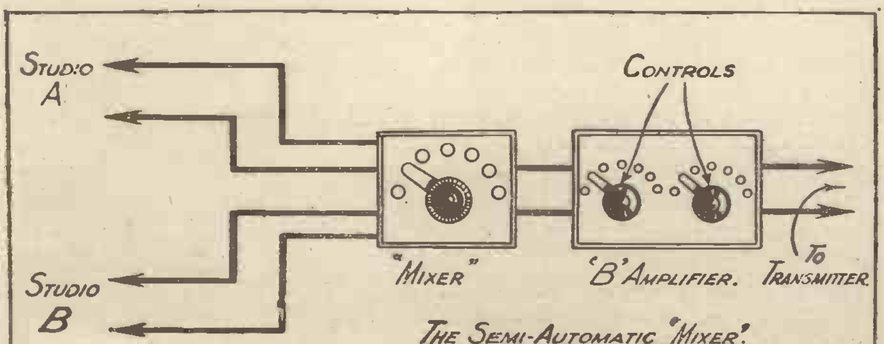


Fig. 2.

results could be obtained by artificial methods. It was exceedingly difficult to get the correct balance of voices and effects, especially as certain of the "noise machines" had no "soft pedals." And so it came about that the Effects Dept. at 2 L O set up in a studio of their own so that their efforts could be "superimposed" on the transmission from any other studio.

Artificial Echo

For some time, experiments had been going on for the production of controllable artificial echo. It was desirable that there should be a certain amount of echo on orchestral items. The mere taking down of the studio



The Semi-Automatic "Mixer."
Fig. 1.

The first broadcast plays consisted of "straight" dramatic sketches and plays spoken into the microphone, assisted, in some cases, by suitable "effects." The effects were in the same studio as the speakers, and had to be very carefully rehearsed and carried out in order not to be ludicrous. In practice it was a case of "when they were good, they were very, very good, but when they were bad they were horrid." It was discovered that real sea waves sounded very "imitation" on certain loud speakers and headphones, while quite convincing

draperies did not produce the right kind of echo; the music became "mushy" and unnatural, and speech or singing in undraped studios was practically unintelligible. Readers will probably be aware of the method now in use for producing "artificial" (and controllable) echo, of which Fig. 3 is a diagram.

There are two microphones in each studio; one, the "direct" microphone, going in the usual way through microphone amplifiers to the Control Room. The second microphone is connected with amplifiers and a loud speaker in the Echo Room. A third microphone in the Echo Room (which is really an undraped studio), feeds on to a microphone amplifier and up to a point in the Control Room. The "direct" and "echo" impulses of a studio are combined on the "mixer," which is adjusted to give the correct amount of echo to the transmission.

For announcements, for instance, echo is entirely cut out; but just before a musical item commences, three or four "stops" of echo are introduced. The chief difficulty of the system is the introducing of just the right amount of echo. Room echo is by no means constant for all audio-frequencies, both with natural or artificial echo, and it usually favours the band of frequencies between 1,000 and 2,000 cycles.

This, unfortunately, is the frequency band which is most emphasised by the poorer loud speakers and L.F. transformers and nearly all headphones. The amount of echo, natural or artificial, which is just right for the best sets and loud speakers is too heavy for the poorer ones. That is one of the reasons that the first broadcasting studios were so much padded and draped.

Without any echo, piano transmission (particularly at the bass end) is very "peaky," and blasts the transmitting apparatus and receivers if not well controlled. And even if "dead" piano transmission does not blast the transmitter it will almost certainly blast those receivers not capable of dealing with heavy bass amplitudes through having insufficient H.T. or through other causes. The position is, in fact, rather complicated.

The Control Panel

However, controllable "artificial" echo is now an actual fact, and is of great use to the radio dramatist. He can take advantage of the facility of "variable acoustics." The mere turning of a knob apparently takes the actors (who are in a "dead" studio) from the "open air" to a "small room," a "Court of Justice," "swimming bath," or a "cathedral"—and all done by the introduction of varying amounts of artificial echo.

Let us consider now what effects it is possible to obtain with the latest "Dramatic Control Board," installed at the B.B.C. (Fig. 2). On this board are eleven knobs, the middle knob of which will fade the left group of five over to the right group. The producer can adjust the exact relative strengths of speech, echo (on the speech) and effects on, say, the first three knobs of the left-hand group.

At the end of the act of a play, he will probably desire to "dissolve" over to music from an orchestra in yet another studio, with the correct amount of echo on that orchestra.

The first two knobs of the right-hand group will be connected through to the studio and its echo rooms, the precise amount of echo having been determined at the rehearsal.

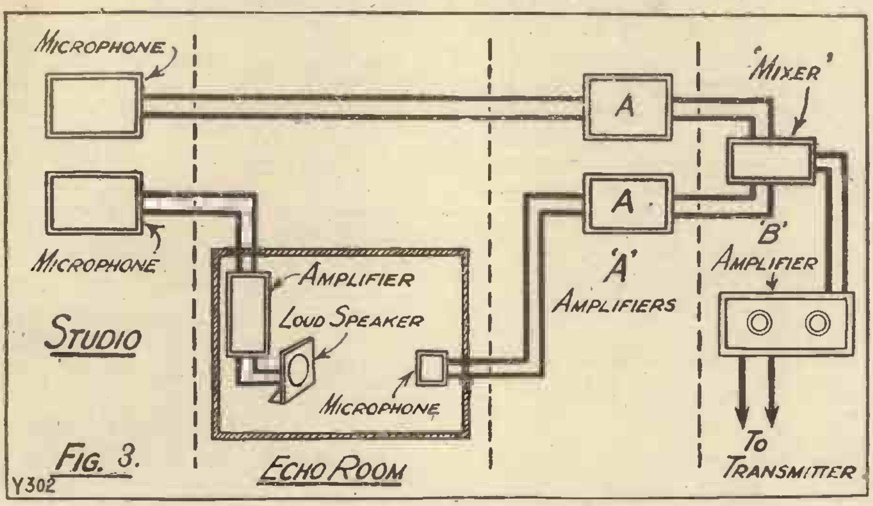


FIG. 3.

The centre knob is turned from left to right, thus dissolving the speech (with echo and effects) over to orchestra (with echo). During the rehearsal the producer is able to speak to the artists or orchestra via a microphone on his desk and loud speakers in the studios concerned. During transmission his directions are received in the studios on a pair of headphones—it would not do for his promptings to be heard on the ether! A high-quality loud speaker is used for "checking" rehearsals and transmission.

Wonderful Effects

The operation of an eleven-knob control board is by no means easy. The adjustment of the right amount of "noises" on to speech is very critical, and certain of the "noises" ("gunfire," "bombs," etc.) have to be made loudly and controlled *ppp* to obtain the right effect. Some wonderful results have been obtained, however, and there is no doubt that in the near future the critical public will appreciate the efforts of a good "balancer" as they probably do a good piece of photography in a film play. Yes; I think we have progressed since that historic broadcast of "Cyrano de Bergerac" from Writtle!

Five years of steady research, investigation and development have left their marks upon our broadcast service—who knows what the next five years will bring forth?

PROLONGING VALVE LIFE

It is not always realised that since a battery is employed for rendering the filament operative and causing it to emit electrons (minute particles of negative electricity), there is a voltage drop between the filament legs which has a certain influence on the life of the valve. Referring to the simple diagram of Fig. 1, the valve filament is shown connected directly across the L.T. battery terminals, and assuming that the resistance of the battery connecting leads and the wires to the filament legs is very small (a fact in actual practice), then between A and B we have the full battery voltage. Taking A as our datum point, then, with a 6-volt L.T. battery, B is six volts positive with reference to A. It is well known that the application of a positive voltage to the plate completes the circuit and the electrons flow from the filament to the plate, thence through the H.T. battery and any associated apparatus, back to A.

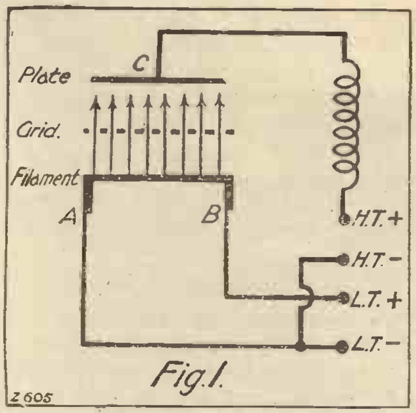
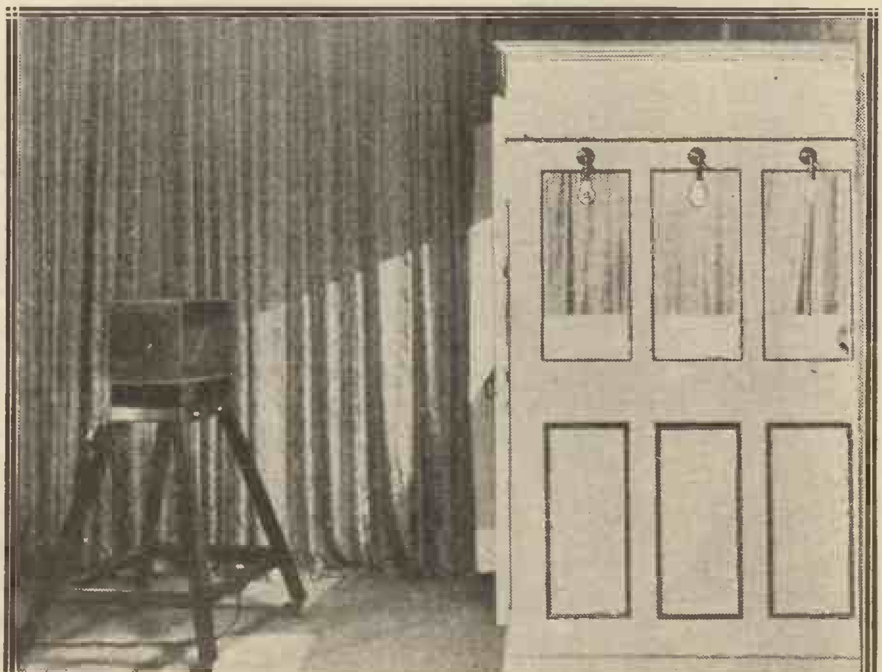


Fig. 1.

There is thus flowing into the filament at A more current than is flowing out at B, and, furthermore, the attracting voltage between C and A is, in our case, six volts more than that between C and B. Under normal working conditions, therefore, the filament end connected to L.T. minus is slightly more overworked than the end connected to L.T. plus.

To counteract the effect, it is sometimes not a bad plan to reverse the filament connections periodically, and thus tend to even out the work undertaken at each filament end.


A sound-proof control box and microphone in one of the London studios.

RADIO ABROAD

French Sets

At the recent Radio Exhibition in Paris, amongst many interesting things which were exhibited were various so-called "frequency-changing" sets which are becoming increasingly popular in France. The two main principles are the super-heterodyne and the double-grid system, the latter having been notably applied in the Ducretet Radiomodulators and various other types of receiver. Four-electrode valves or, as they are more commonly called on the Continent, four-grid valves, are being more and more widely used.

A new kind of frequency-changing set was shown by M. Lucien Levy, the well-known French inventor. This employs a special valve which is claimed to give results equal to those of the four-electrode type.

Four Electrodes

In this new valve there is no cylindrical element, the four electrodes being flat, and the plate being duplicated instead of the grid. The second or auxiliary plate is placed behind the filament, so that instead of the usual four-electrode arrangement of plate, grid, auxiliary grid and filament, we have plate, grid, filament and auxiliary plate.

Considerable interest has been aroused in this new valve, in view of its claims to do what has previously been so extensively accomplished by means of the conventional four-electrode valve.

Mystery Valves

Another interesting feature, which has been described in the French Journal "l'Antenne," is a four-valve set in which the valves are concealed in a block of moulded insulating material. This was described as a valve-less set, and enormous claims were made for it, in addition to which it was for some time surrounded in mystery.

French H.T. System

At a recent meeting of the Academie des Sciences, a discussion took place upon a new kind of gas-discharge valve which has been invented by Monsieur Rislio. It was shown to be possible to obtain equilibrium of the gas pressure of these valves by means of a discharge of vapour on the passage of the electric current.

This system of automatic regulation should make it possible to supply the H.T. to a set by means of a filamentless supply valve, the gas pressure in the latter being, of course, maintained constant. Apart from certain other important advantages, the fact that the supply valve has no filament gives it a much longer life and renders it more robust and fool-proof.

Radio In Asia

Now that radio has attained to such a prominent and permanent position in the civilised life of the Western countries, its benefits and advantages are being realised in the East. It is not more than a year or so ago that there was scarcely a broadcast station on the mainland of Asia, but now almost every few days brings the announcement of some installation, often of considerable power.

German radio-set designers are concentrating on simplicity of control in the same way as the experts of other countries. Above is shown a Lorenz valve set for local station reception.

Until a very short time ago even radio reception was taboo in China, where, however, there are now several broadcasters. Transmitters of high-power have been installed in India, and the Soviets are entering upon a most ambitious programme not only in European Russia but also in the vast area of Northern and Central Asia.

The Mohammedan countries, proverbially lethargic, are moving in the matter of radio, and Turkey has taken the lead in the development of Government broadcasting, whilst other surrounding countries are actively considering or dealing with the radio question.

German Novelty

A curious radio novelty from Germany is a postcard receiving set which has just lately made its appearance. This unusual receiver resembles an average illustrated postcard of the size of about 5 in. by 3 in. It is, of course, rather thicker and heavier than the ordinary postcard. One side of the card is decorated with a picture, and on the front a line divides the card into two sections.

Space is left for the stamp and address, whilst on the left side of the line are the tuning controls and four points for electrical contact. The postcard receiving set incorporates a crystal receiver circuit. The tuning inductance of the set is a spider-web coil, the detector is of the adjustable galena type, and the tuning control is a slider which makes contact with the various turns of wire on the coil. The coil is $2\frac{3}{4}$ in. in diameter and wound with No. 28 enamelled wire.

"American Antenna"

An interesting new aerial which has just appeared on the United States market is known as the "American All-Direction Antenna," and consists of a ring, 14 in. in diameter and about 4 in. deep, like a horizontal slice from a vertical tube, this being mounted by means of a four-legged spider support upon a small cylindrical tube designed to fit upon the top of a mast. It is made of pure copper and is claimed to receive equally from all directions. A typical American announcement of the new device urges you to "take down that old aerial, don't wait until it blows down," and then presumably to erect the all-direction antenna in its place!

An Electric "Organ"

Everyone knows the effects of hand-capacity—how a set will squeal sometimes on the approach of the hand to the coils or condensers, and how the squeal changes in pitch with the movement of the hand.

This effect, usually regarded as an abomination, has been turned to useful effect in a new instrument designed by Professor Leo Theremin, of the Physico-Technical Institute of Leningrad, who recently gave a demonstration before a group of musicians, scientists, and others in Berlin.

So far, only a single instrument has been demonstrated, but the inventor

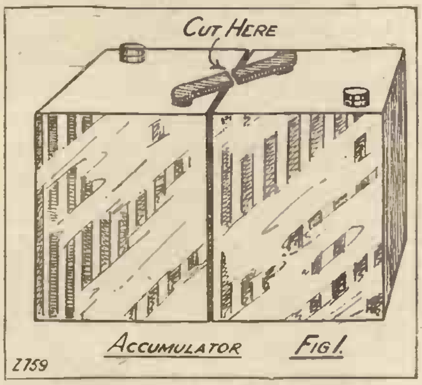
(Continued on page 110.)

REPAIRING ACCUMULATORS

A really practical and helpful article that may save you from having to buy a new Low-Tension Battery.

By C. W. PEARSON.

NEARLY every radio amateur of any standing has a junk heap, and it is fairly safe to assume that seventy per cent of these will



house an accumulator that has "konked" out. Often a little care and manipulative ability will place these worn-out batteries in a different sphere, and possibly the amateur may obtain as much as from six months to a year's further service.

Necessary Precautions

Bearing in mind that often only a small repair may be needed, the writer sat down and penned this article with a view to assisting the amateur in overhauling his battery. While it is quite possible for an interested operator to make a satisfactory job, it must be pointed out that in the overhaul and repair of accumulators the pitfalls that are likely to be met with are many. Another point to be emphasised is the question of clothing. Sulphuric acid creates an uncanny feeling on the skin, and the beginner is tempted to wipe his hands upon his clothing in order to allay the irritation. Clothing and acid never did agree together, and the clothing loses badly. Be prepared and don the oldest clothing possible. Always keep a vessel near, so that the hands may be dipped into a medium-strength soda solution. This neutralises the acid and allays the irritation. The soda solution will also be useful in quenching any acid that is spilt upon the clothes, and by its free application preventing large holes appearing after a lapse of a day or two.

Remember that the main constituent of the battery is lead and its compounds. In all forms this is a potent poison, so that a few precautions are necessary. These are tabulated under:

Do not smoke while at work on the battery, as lead can be easily introduced into the system through the cigarette or pipe. Also keep the hands away from the mouth, paying due regard to finger-nails.

Cut the finger-nails as short as possible before starting on the task. Be very careful to scrupulously clean the hands before eating anything.

Cover the clothing with some form of apron or overall, and try not to enter the dwelling part of the house in the clothes used during the task.

A cap will prevent dusty lead from getting into the hair.

An old pair of gloves will adequately protect the hands.

An old pair of goggles or glasses keeps acid away from the eyes.

Be careful not to spill acid upon the boots. Sulphuric acid quickly rots boots.

Regarding the eyes—if you should spill or splash any acid so that the spray gets into your eyes, immediately bathe the affected member in warm water, preferably by means of an eye-bath, in order that the lids may be opened and closed, thereby swilling the acid out. Olive oil should then be dropped into the eye by means of a match-stick, but if no oil is at hand, use clean thin lubricating oil, raw linseed oil, or vaseline. If all these "don'ts" have not deterred the reader, he is ready to commence.

Preliminary Examination

First, an examination of the battery, if carefully carried out, will often show the cause of the trouble, but if nothing can be seen by looking into the inside of the cells, it does not necessarily follow that the battery is O.K., as there are a large number of invisible faults possible. If the battery is the multi-cell variety, i.e. 4 volts or 6 volts, a close examination should be made of the top connecting straps, making certain that the joint is firm to the centre post. A weak joint is often the cause of no current flowing. If such is the case, the remedy is obvious, i.e. remove the strap by cutting away with a hacksaw, being careful not to damage the post which is fastened on to the plate

Fig. 2.

Cut through the celluloid with a sharp penknife, as shown.

strap. If the strap is broken beyond repair, a new one may be cast in a plaster-of-Paris mould, or failing that, a sheet metal one can be easily cut from an old piece of lead water pipe. Gas piping is useless, as it is not pure lead. If a piece of old lead water pipe is vertically sawn through with the hack-saw, it will be found on flattening the two pieces out that useful flats of lead are obtained. (The method of fastening these straps is treated later.)

Should the outward examination show no reason of breakdown, it will be necessary to open the cell and remove the plates.

Cutting the Straps

In these days valve users select either 2-, 4-, or 6-volt batteries. Sometimes they, are built up out of the popular 2-volt glass cells now being sold, and then, again, for the sake of neatness, may be of the multiple cell type, joined together in the construction of the container. Whichever type is used, the fact remains that they must be disconnected down to the individual cell stage before the groups of plates may be withdrawn. It is fatal to the battery to try and withdraw the plates altogether, as the lead is usually crystalline, and the pressure necessary will cause damage to the plates. Again, the groups will not pull evenly when they are drawn together.

The cutting of the straps calls for some care. It should be remembered that, however carefully they are cut, it will be almost impossible to make a good job of joining them when reassembling. There is one method that is slightly less doubtful than other ways, and this will be dealt with under assembling; but if the straps are cut anywhere else but the centre between the partition wall, it will not be practical to resort to this method. If the reader has no facilities to make new straps, and the old ones are required to do service again, cut the strap as shown in Fig. 1. When the battery is four volts or two cells, only one strap is present, and in the six-volt or three-cell type there are two.

Further Dismantling

Assuming that the reader has cut his straps, the next step is to open the tops of the cells. Once again, great care is necessary, as the lids of the accumulator are firmly attached to the walls. The cement used is of such a nature that the lid becomes one with the wall, not as in the case of glue and wood, but for all appearance a right-angle bend of sheet celluloid. Thin narrow strips of celluloid are cemented inside the container on the underside of the lid, to form a rest, and similar strips are placed over the lid and again cemented to the wall.

In the cheaper class of batteries, this latter refinement is usually left out, but we will treat it as though it were present. A sharp knife will be found to be the most useful tool to remove the strips. First cut the strip with as little damage to the wall of the cell as possible so that the thin edge of the knife blade may be inserted and used to prise the strips away. Once a start has been obtained the remainder will be simple. The photograph, Fig. 2, shows the procedure quite plainly.

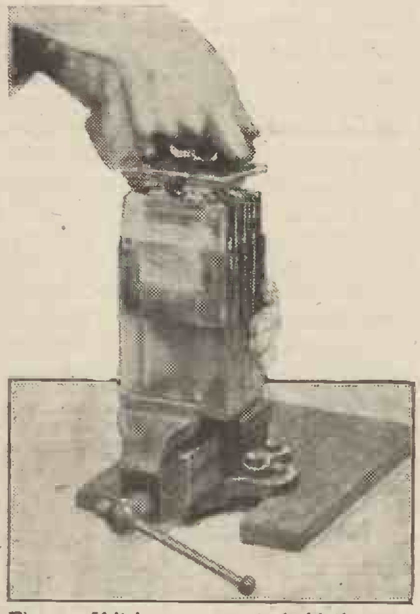


Fig. 3. If it is necessary to hold the container in a vice care must be taken that the celluloid does not collapse.

After the strips are all away from the top, the next step is to remove the lids. Carefully insert the knife blade, taking care that the rest-strips beneath the lid are not damaged, and again prise the edge of the lid from the wall of its container. After all four sides have been gently forced away the lid will be free and loose, ready to be lifted out with the plates as a complete unit. Before removing from the cell, it would be as well to make some mark on the lid and cell wall, in order that the lid will assume the same position on assembly.

To remove the plates, the reader will have to devise some method of holding the container so that the group can be pulled away. Some force is often required for this, and if the aid of a pair of strong hands can be obtained, so much the better. Failing this, the container must be held in a vice, exercising due care so that the celluloid does not collapse. Little and often is better than a broken cell, so apply the pressure at the extreme bottom of the cell away from the plates, a little at a time, endeavouring at each extra pressure to pull the plates away. Obviously the pressure does not influence the removal of the plate, it merely serving to hold the container firmly. When the plates come away, the complete assembly should be placed in a pail of water. The method of holding the cell is shown in Fig. 3.

Storing the Plates

When the plates have been removed from the cell, they should be placed in a vessel and covered with water. The reason for this lies in the fact that the spongy lead in the negative plate is very active and attracts the oxygen from the air. The conversion of the finely divided lead into lead oxide is attendant by great heat, and ultimately results in a hard, almost solid, mass. The heat of combination also causes the sulphuric acid in the paste to attack the spongy lead, thereby completely changing the physical and chemical characteristics of the plate. An inexplicable phenomenon in connection with plates is that the positives buckle when exposed to light, the side facing the source of light becoming concave. To be on the safe side, therefore, keep the group covered in water and in a dark cupboard.

Group Separation

Should examination of the plates indicate that complete separation of each group is necessary, i.e. the positive group from the negative, it will be necessary to treat the post in such a way that the lid will slide over the top. The bridges must be cut as close to the posts as possible, without damaging the latter, as it must be pointed out that to fit a new post, lead burning must be resorted to, and the amateur will experience great difficulty, with remote chances of success, at this highly skilled operation. I have seen various attempts at amateur lead burning, and nearly always the damage has been increased instead of reduced After cutting the connecting bars, small projections of lead will probably remain on the posts which will prevent the passage of the lid, and to remove these a boot repairer's rasp will be found useful. If a fine file is used clogging will quickly retard the cutting progress. Clean the posts so that they are as perfectly cylindrical as possible. A hollow rubber cork forms the bush in the lid through which the post passes, and on the top of the rubber bush a disc of coloured celluloid is fastened. This disc is merely a finish, added to the cell for appearance sake, and coloured either red or black as an indication of polarity. Using the blade of the knife again, it will prise away quite easily. Before the lid can be removed, it is necessary to turn the rubber bush by means of the fingers, thereby softening the rubber and preventing damage. The rubber is inclined to get hard and perish in the presence of the acid, and also through the variations in temperature that are present in charging. When the bush is loose on the post and lid, the post should be wetted with water and gently pulled through the bush, the water serving as a lubricant.

Cleaning the Container

We now have the batch of plates and separators held together as a unit. By gently sliding the plates apart the separators will fall away. The appearance of the accumulator should now be something like Fig. 4, but will differ according to the number of cells that the battery contains. The components should be carefully washed, exercising due care that no damage takes place through unnecessary force. All sediment at the bottom of the container must be removed. Sometimes this assumes a concrete-like structure that agitation and swilling with water will not affect, and in this case use a piece of wood, gently scraping the top and gradually working down to the lower parts, keeping the deposit covered in water the whole time. No force must be used, or it will be found that a leaky container will result.

The Separators

There are two varieties of separators in use in cells which do not use the ribs of a glass container as separators. These are either corrugated ebonite or celluloid, or almost pure cellulose which looks like wood. To effectively cleanse these the writer uses an old tooth-brush and water, removing any hard deposit by means of a piece of wood. Here, again, exercise due care so that the separators do not get broken. The softer deposit will come away quite readily by flowing water from a tap or agitating the separator in a pail. The wooden or cellulose separator is very much more delicate than the celluloid variety, so that greater delicacy of handling is necessary.

After cleansing, the separators should be placed in an upright position to drain and dry. If examination shows any signs of cracking or fracture, it is better to scrap the separator and replace it with a new one. It is not generally understood that the condition of the separator greatly influences the internal resistance of a battery, and as this affects the general functioning of the output, the importance of perfect separation cannot be stressed too greatly. (All forms of accumulator separators are manufactured by Messrs. Fredk. J. Gordon, Ltd., 92, Charlotte Street, London, W., so the amateur will experience no difficulty in obtaining supplies.) It is necessary to mention that the same form of separator originally used must be replaced, as the manufacturers of the battery have spaced the plates to allow for a definite type. In seeking replacements it would probably be as well to forward one of the worn separators as a sample.

The container must be tested for leaking seams, etc., and in the case of the multiple-cell battery this is very important. To merely place water in the cell and watch for exudations of moisture is almost futile. The wall of the cell in all cases is made from an insulating material, either glass, celluloid, or ebonite. Consequently, if perfectly tight, it will effectively prevent any passage of current. By filling the cells with a conductor of current, i.e. water and acid, and connecting some form of current to each of the cells in turn, using the separation wall of each cell to keep each conductor of the ingoing current apart, minute leakages quickly indicate their presence.

Tracing Leaks

A minute crack or leak, that would barely show a hair-like exudation of moisture, forms an effective passage for a relatively heavy current. The lighting mains are the best means of testing current, but failing this either a 12-volt or 6-volt battery will suffice. Clearly, an hour or so should elapse after filling the cells with water before the test is made, thus permitting the filling up of the leaking aperture with water. Some form of indicator is required to point out the passing of the current, and reference to Fig. 5 will indicate the assembly, and also the fact that a lamp is used to prove the passage of current. This test is very reliable, and it may be added is a trade method of detecting leaky containers.

Fig. 4. The separate parts of a typical accumulator are shown in this photograph. There are, of course, slight differences with different makes.

The effects of leakage may be so far reaching as to cause an easy path for the passage of current between cells, and it is against this that a special method of examination is adopted.

Should the celluloid cell be found to be leaking, it must be repaired before reassembling. In the event of the inter-cell leakage being small, it is possible that some difficulty may be found in finding the leak. One of the best methods is to gradually lower the level of the water in the affected cell by about a quarter of an inch at a time, when a point will be reached when the light goes out. Naturally, it is necessary to dry the wall above the liquid each time that an extraction is made, otherwise it is possible for the current to travel through a column of adherent moisture. By carrying out this test carefully, a point will be found where the leakage is present, thus reducing the area to a band of a quarter of an inch, or such dimension as the level of the liquid in the cell has been reduced each time.

If the exact location of the leak cannot now be found, the best method is to stick a small piece of celluloid sheet completely round the area in doubt, using angle celluloid for the corners. The cement and celluloid sheet can be obtained from any dealer in motor-car accessories, and if not in stock they will quickly get it. A word of caution is necessary in using celluloid cement. The surface to which it is applied must be perfectly dry and scrupulously clean. It should be scraped with a knife so as to present a roughened surface.

Renovating the Cases

On the bottom of the container will be found some form of rest upon which the plates stand. For some unaccountable reason these very often work loose, so that they should be closely examined, thereby making sure that they are fast. If this is neglected, there is a great possibility that a broken plate will result, as the weight of the group is then upon the straps. Should the examination show any defect, the rest must be secured by the application of cement.

Celluloid containers get opaque as they age. If it is desired, they may be cleared by the use of either white vinegar or dilute acetic acid, it being necessary to merely wash the celluloid with a piece of rag. Old celluloid can never be given the glass-like clarity of the new product, owing to the surface having become covered with minute pits, these being responsible for the matt-like surface, and effectively retarding the passage of light necessary for transparent materials. The pits are produced by the action of the sulphuric acid upon the camphor used in the manufacture of the celluloid. Incidentally, this is responsible for the annoying frothing apparent during accumulator charging.

In the event of the accumulator being of the ebonite variety, a leaky case will necessitate a replacement. It is possible to repair the leaky case by vulcanisation, but the process is one which is not within the possibilities of the amateur. The cost of the repair compared with the cost of the replacement indicates that the latter method is the better of the two.

A leaky glass container is almost out of the question, so that it would be unnecessary to give it any mention.

Treatment of the Plates

An examination of the plate assembly will show any apparent faults, the most likely to be encountered being: Sulphation, distorting of plate, loss of paste, fractures, bulging of the active material in the plate, and granulation of the negatives. Each will be treated in turn.

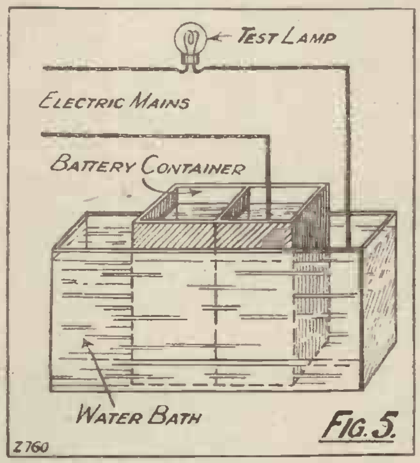


Fig. 5.

Sulphation. Many people speak of a sulphated battery as though the lead sulphate is something which has crept into the cell from an inexplicable source, in much the same manner as the cuckoo's eggs get into another bird's nest. Sulphate is formed and is necessary in the working of every battery, and it is only when in excess that its presence is an evil. When a correctly charged cell is used, lead sulphate is formed as a product of discharge, and on recharging resolves itself into its components. Theoretically, therefore, the reader will reason that conditionally that the cell is only charged and discharged to a perfection point, no sulphate should form. This is only correct to a certain degree, but owing to other conditions present the sulphate is always growing. The treatment that the battery receives considerably assists or retards the progress of formation. Thus the battery whose discharge is habitually carried in excess, will always present a greater amount of sulphate than the charging process can deal with, and the greater neglect on discharge that the battery receives the greater is the rate of excessive deposition, with the possibility of an early breakdown always present.

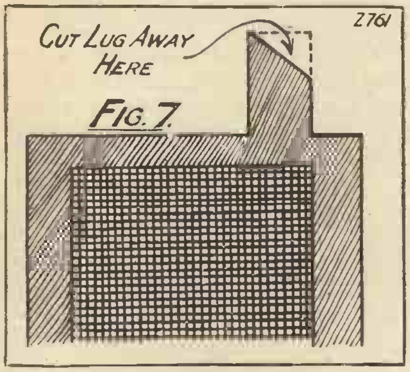
Removing Sulphate

The best method of sulphate removal is that known as a correction charge. It may be pointed out that the sulphate formed during the legitimate functioning of the cell is of a different structure to that of long standing. As time goes on, the aged sulphate assumes a hard crystalline structure, which is highly resistant to all known methods of removal, and, moreover, is a good insulator. By passing a low current into the battery sulphate can be gradually eliminated, but at all times it is a long and tedious process. The rate for the entering current is determined by dividing the actual (this is important) capacity of the battery in ampere hours by thirty. Assuming that the battery is one of fifty actual ampere hours, the correction charge rate should be fifty divided by thirty, which is 1·66 amps. Obviously, the charging method of sulphate removal can only take place in a completely assembled battery, i.e. positive and negative plates in position with separation.

From time to time writers in the technical Press advise a scraping of the plates to remove sulphate. In the writer's opinion this is a useless remedy, as, apart from the unnecessary removal of active material from the grid, the structure of the plate still remains dense, whereas by the slow correction charge the original porosity of the plate is restored, and no undue shedding of paste is apparent.

A Second Method

Another very good method of sulphate elimination is to steep the plates in an aqueous solution of chloride of lime. To prepare the solution, take from four to six ounces of good chloride of lime and agitate it in a quart of cold water. Allow the milky solution to settle, and decant or pour off the clear portion, covering the plates with this. After about twenty-four hours have elapsed, there will be a marked diminution of the sulphate, but a rule to adopt is to give the pickling process forty per cent over the time to remove all visible traces. During the steeping, the colour of the plates change to an alarming degree, but this is quite harmless, as on charge they resume their normal colour. When satisfied that the process has been carried to completion, wash the plates carefully in clear cold water. The writer has resorted to this method frequently with great success.



Distorted Plates and Bulging of Active Material

When the plates are removed from the cell, and show signs of twisting or deviation from the perpendicular, they must be carefully pressed back into their true position. Before separating the complete group, and while the separators remain in position, the distance between positive plates should be accurately measured. Pieces of hard wood are then made so that the dimensions are slightly in excess of the plate excluding the lugs attached to the bridge. The packing pieces required will be of a sufficient number to allow for one on the two outsides of the group, and one for each space in between the plates. Thus, in a four-plate group, five packing pieces would be wanted, as there are three spaces in between the plates, and one piece on each outside surface of the plates. The whole assembly is now firmly clamped in the jaws of a vice and left for about two hours, thereby pressing the paste back into the plate, and at the same time correcting distortion. Fig. 6 shows clearly the operation.

Loss of Pas e

If the plates have been treated badly, or, on the other hand, have lived the allotted span, the paste will fall out to the bottom of the cell, forming a "mud." The amateur can do little to remedy such a defect, the best way out being to forward the group to the makers and ask for a replacement. It is nearly always the positive group that falls to pieces, owing to the delicate nature of the paste. This is lead peroxide, and unless a certain amount of sulphate is present, it is always in a soft state. The presence of a little sulphate in the positive plate is advantageous, as it tends to cement the fine grains of lead peroxide together, thus giving it a firmer structure. Pasting at all times is a messy and difficult operation which calls for a special knowledge, besides being dangerous to the careless worker. Again, the amateur would have to remove the plate from the bridge to apply the new paste, and as this calls for lead burning, it will be cheaper in the long run to get a new group.

Fractures

Vibrating and variations in temperature equally contribute to the formation of fractures. When the break appears in the active part of the plate, the only remedy is to completely remove the plate from the strap at the top and replace it with a new one. Assuming that the replacement is on hand, the procedure to adopt is to prepare the work and take the complete group to a good oxy-acetylene welder and have the new plate burned into position. Any good welder will do this for a few coppers if the work is prepared for him in such a way that he only has to apply his flame and complete the job. If the preparation of the work is left to him, his time becomes chargeable in addition to the welding, with a relatively formidable bill in the end.

The part of the strap from which the old plate has been cut should be filed clean with a rasp, removing no more metal than is absolutely necessary. The surface exposed is now scraped with a sharp knife, and immediately smeared with a piece of good tallow. This leaves a clean surface of lead exposed to the action of the burning flame, the tallow serving to prevent oxidation. The lug of the new plate is now cut to correspond in length to its fellows in the group, the top cut "on the skew" as in Fig. 7. The lug should be filed and scraped and smeared with tallow as before.

By utilising the clamping method described under the heading "Distorted Plates," but substituting a screw clamp for the vice, the assembly is ready for the welder.

After burning the plate into position the surplus metal should be carefully removed by a file, so that a clean appearance is given to the group.

Treating Granular Negative Plates

The cause of granulation is unavoidable, as its formation is of the natural fuuctioning of the battery. The impression that the battery repairers receive from granular negatives is that the treatment of the accumulator during its useful life has been good, as it is really an ageing of the spongy lead.

The remedy is to take the complete group of negatives and place them in a bath of dilute sulphuric acid having a specific gravity of 1·200. Thin sheets of lead between $\frac{1}{16}$ and $\frac{1}{8}$ in. in thickness are also placed into the bath, endeavouring to arrange so that a sheet of lead is between two negatives, the arrangement being shown in Fig. 8. A charging current is now passed through this concocted battery, the positive lead connected to the original negative plates, and the negative to the lead sheets. This converts the hard granulated lead into lead monoxide, which then turns to lead peroxide. A fair period should be given for this conversion at about half the charging rate advocated by the makers, and the period of passing the current should be doubled. Assuming that the charging rate is four amperes for twelve hours, the connection charge should be two amperes for twenty-four hours.

Ready for Reassembly

The old electrolyte should now be poured away, and new added as previously described. The leads of the charging current are now reversed, so that the negative lead is attached to the negative plates and the positive to the lead plates, the

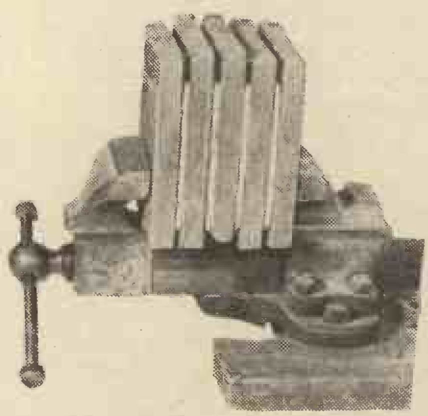


Fig. 6 To press the paste into the plates, the assembly is clamped in the jaws of a vice for a couple of hours.

charging current is again passed, when the lead peroxide from the previous charge is changed into the original spongy lead present in the negative plate. If the above directions are carefully carried out, a marked improvement in the capacity of the cell will result. (This method of treating granular negatives is generally adopted throughout the trade.)

The components have now been cleaned and any faults that were existent have been remedied, so that they should be ready for reassembling, but before this can be done a supply of celluloid cement must be obtained. This can either be purchased or home-made quite easily, the components being merely clear celluloid cuttings dissolved in acetone or amyl acetate. Either will do, and the celluloid should be added until the solution is of a consistency of glycerine.

The Celluloid Cement

About one fluid ounce will serve to reassemble a medium 6-volt battery. The surface to which the cement is to be applied must be very clean and well scraped with a knife, after which the cement is applied with a small paint brush of the artist camel-hair variety. If properly executed a strong joint will always result.

Take a group of positive and negative plates, with the requisite separators, and interleave them in position. The negative plate is grey, while the positive is chocolate red, or the positive group may be distinguished from the negative one if it is remembered that there is an extra negative plate per cell. Should the outer negative plates be slightly distorted so that they do not present a compact shape, it will be found that they will easily press into a dimension that permits insertion in the cell by means of hand pressure, but failing this, the vice must be resorted to. If this can be avoided so much the better, as when the batch of plates are assembled with separators, they are relatively delicate.

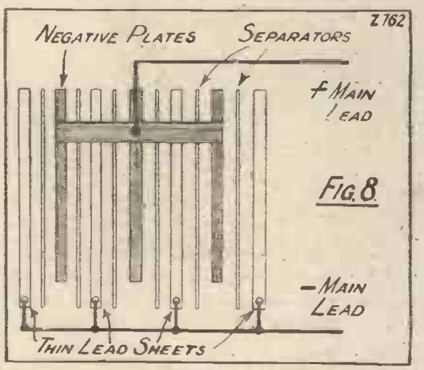


Fig. 8

When placing the plates into the cell it is not advisable to use any other pressure but the hands. They nearly always go down into position if a firm but gentle pressure is used. See that the bottoms of all the plates are level with the rest piece on the bottom of the container. The rubber bushing pieces should now be placed into the correct positions in the lid. If they show signs of being perished and badly cracked, new ones should be procured from the makers, otherwise creeping of the acid will take place, thereby causing corrosion of terminals, and a dirty wet top. Before pushing the lid over the posts, it is advisable to wet the lead so that no undue pressure is exerted. It is as well to see that the strips of celluloid upon which the lid rests are securely cemented into position before the lid is pressed home. On some batteries it is possible to spring the sides out so that the plates may be withdrawn, but if the sheet celluloid is of a stout gauge, it will spring very little, this necessitating the complete removal of the strips. Should this have happened they should be placed into position immediately after the insertion of the plates.

Re-connecting

Smear the underside of the lid with cement, and apply a little to the strips on the side of the container, and gently push the lid into position. The cell should now be left for a couple of hours to enable the cement to thoroughly dry. After this, the lid must be secured, either by sticking small strips of celluloid on the upper side and the wall of the container, or by binding with cement. This is simply painting a layer of cement in the cracks at the edges and leaving it to dry, giving about three applications.

The multiple-cell battery will now be ready to have the connecting straps fastened into position. The operation calls for a small amount of skill and care, but given a little attention, it is fairly simple. Where the strap was cut in the centre it should be cleaned and cut to a V, as Fig. 9. Clean both edges of the V, so that the new metal to be added will be able to firmly attach itself to the existent strap. Cleanliness is very important. Lightly smear the bright metal with Fluxite, and tin each side of the V with solder, being careful that none falls on to the celluloid. As a precautionary measure, place two or three thicknesses of newspaper under the strap so that any molten solder that falls will not burn the celluloid.

Providing New Straps

After tinning, fill the V liberally with ordinary solder, leaving sufficient surplus so that it may be filed away to leave a workmanlike surface. After clearing it away neatly, paint the strap with anti-sulphuric-acid paint, as a means of protection.

If the old strap was destroyed, new ones must be made. The easiest method is to cut them from stout lead sheet, drilling a hole at each end for the post to go through. Clean the old paint off the post and tin with solder as previously described. Tin the eyes of the connecting straps and clean away any surplus metal until the post just enters the eye of the strap. Liberally solder the post to the strap.

Fig. 9

clean away the surplus metal, and paint with anti-sulphuric paint.

The methods described above are exactly as resorted to by trade repairers, so that the amateur may rest assured that, providing due care is exercised, his success will be certain.

The "Straight" Two-Valver

Some Readers' Results

Sir,—I have constructed the "Straight" Two-Valver as from your paper of October issue.

The results I have obtained are truly wonderful. I have a poor aerial and earth system. The aerial is only 25 ft. long, a twin, and 15 ft. high at one end, and 35 ft. at the other, and earth is 10 ft. long. I can get most continental stations, including Madrid and Barcelona, nightly.

Using a neutralising condenser in series with aerial, I now get K D K A nightly at good strength (about as loud as local reception on a crystal set), 62·5 m.

On short-waves, however, capacity effects are troublesome.

The set is the more remarkable because I have built many multi-valve sets as far back as 1922—without getting as good results.

I have not made one soldered connection.

Assuring you of my staunch support of your interesting and instructive journal.

I remain,

Yours faithfully,

A.K.

London, S.E.23

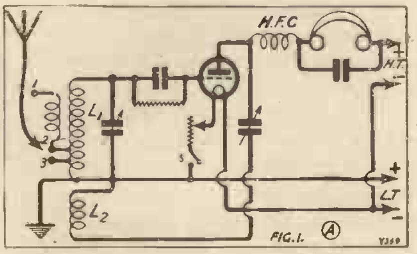
The "FLEXIBLE" ONE VALVER

Two forms of capacity-controlled reaction are incorporated in this novel receiver.

By G. T. KELSEY.

If the number of squeals between the hours of 6 and 8 p.m. on a Sunday evening is any indication, I should imagine that a set in my locality without reaction must be something of a curiosity!

Seriously speaking though, although there are people—fortunately few—



who abuse its use, a one or two-valve set without reaction is of little use, and is almost comparable to the proverbial donkey tied to a post; it can get so far and no farther.

YOUR SHOPPING LIST.

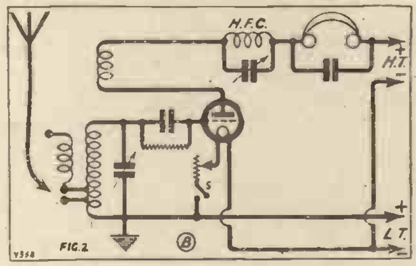
- 1 Ebonite panel, 7 in. × 12 in. × ¼ in. (Radion).
- 1 Cabinet for above, and baseboard 7 in. deep.
- 1 S.L.F. slow-motion variable condenser, ·0005 (Jackson).
- 1 Ordinary square-law variable condenser, ·0003 (Jackson).
- 1 Three-pole change-over switch (Utility).
- 1 Two-way push-pull switch (Lissen).
- 1 H.F. choke (R.I. & Varley).
- 1 Anti-microphonic valve holder (Magnum).
- 1 Fixed condenser, ·0003, with clips for grid leak (T.C.C.).
- 1 Grid leak, 2 megohms (Dubilier).
- 1 Fixed condenser, ·002 (T.C.C.).
- 1 Baseboard-mounting filament resistance to suit valve (Igranic).
- 2 Single-coil mounts (Lotus).
- 1 Terminal strip carrying 6 terminals.
- 1 Terminal strip carrying 2 terminals.
- 2 Clix plugs and two sockets, Glazite, flex, screws, etc.

On the other hand, given a good single-valve set with fine reaction control, it is really surprising the number of stations that can be heard at fair strength on the telephones. Obviously, reception conditions have a lot to do with it, but there is almost bound to be one or two of the more powerful stations coming over at sufficient strength to provide an alternative programme.

Smooth Reaction

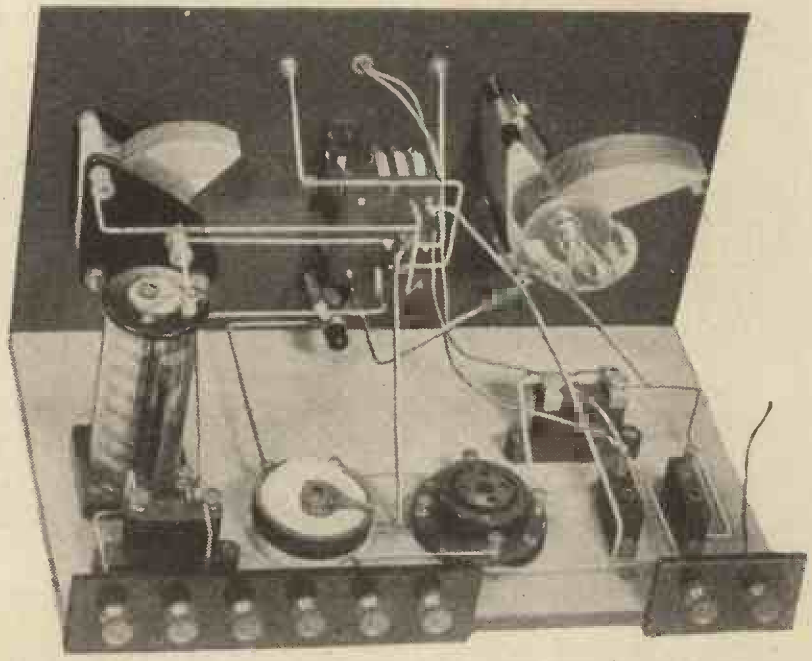
To be able to search for distant stations successfully the set must be reasonably efficient, and, above all, the reaction must be finely controlled and smooth.

Probably most readers will be familiar with the type of set which changes into an oscillating condition with a noise very much akin to that of a door banging, and such a set is useless when it comes to receiving distant stations.



Since so much depends upon the use of reaction in small sets, and finely controlled reaction at that, there is much to be said in favour of a capacitative form of reaction control.

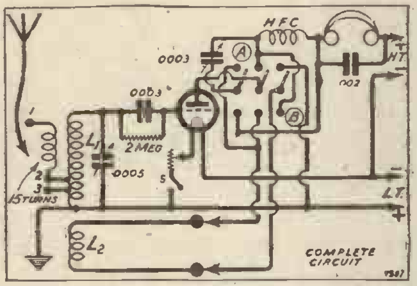
Perhaps the most familiar condenser-control arrangement is the Reinartz, a form of which is shown



The simple nature of the receiver enables it to be constructed in a very short time.

in Fig. 1. This arrangement, although probably the most popular, is not the only circuit in which a condenser is used for reaction purposes, and an interesting variation is shown in Fig. 2.

These are both well-tried and reliable arrangements, and in view of the interest in comparing two circuits, the set about which a

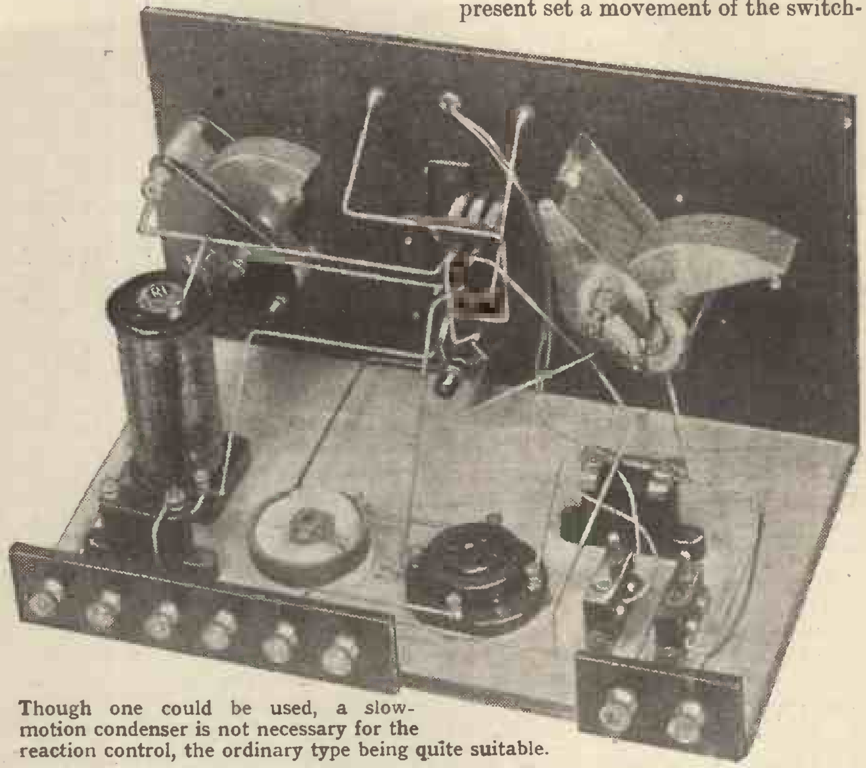


description is shortly to follow has been designed with a switch enabling either of the two circuits to be tried at will.

Variable Aerial Coupling

The "Flexible" One-Valver certainly lives up to its name. In addition to the fact that it is really two circuits in one set, there are several other small points in which it differs from the conventional single-valve arrangement. For instance, there are three tappings to which the aerial can be connected; thus the ratio between signal strength and selectivity is variable. In this respect, and before proceeding, it would be as well to explain what is meant exactly by this term "ratio." The attainment of a high degree of selectivity with almost any single-valve detector circuit is of necessity accompanied by a slight loss in signal strength. Now, by being able to vary the degree of selectivity the set can be adjusted to suit individual requirements.

A second point in connection with the flexibility of the set is that provision is made for reversing the leads to the reaction coil without having to grope behind the panel with a screwdriver. In an ordinary single-valve set this refinement is not necessary, but since in the present set a movement of the switch-arm completely changes the circuit it is possible that the reaction-coil leads will require reversal.



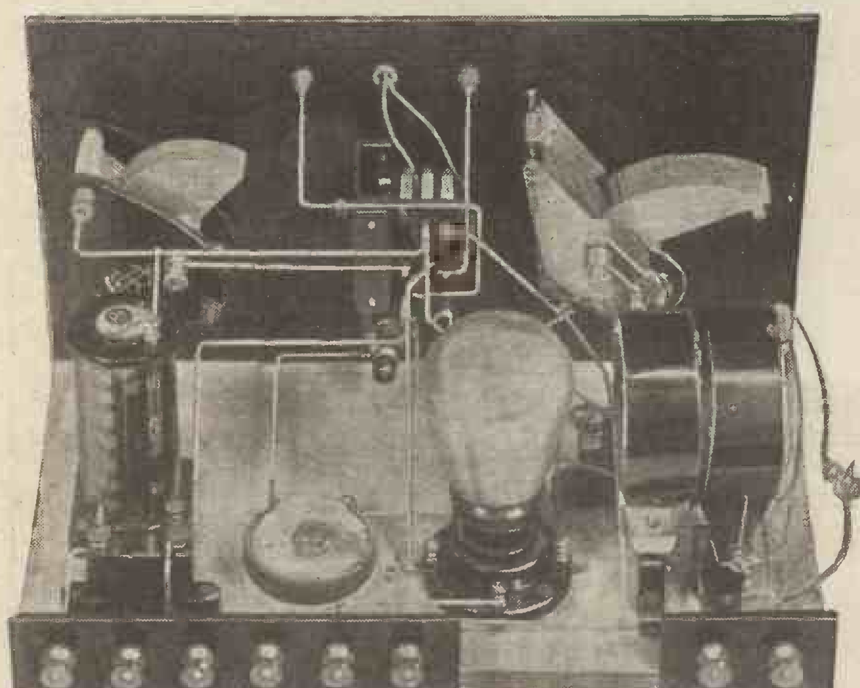
Though one could be used, a slow-motion condenser is not necessary for the reaction control, the ordinary type being quite suitable.

The set, even from the beginner's point of view, is not difficult to construct, and the only point requiring a certain amount of care is in the wiring of the switch. For this particular component soldering is almost indispensable, but it should not be difficult, since all the tags are ready-tinned.

Commencing Construction

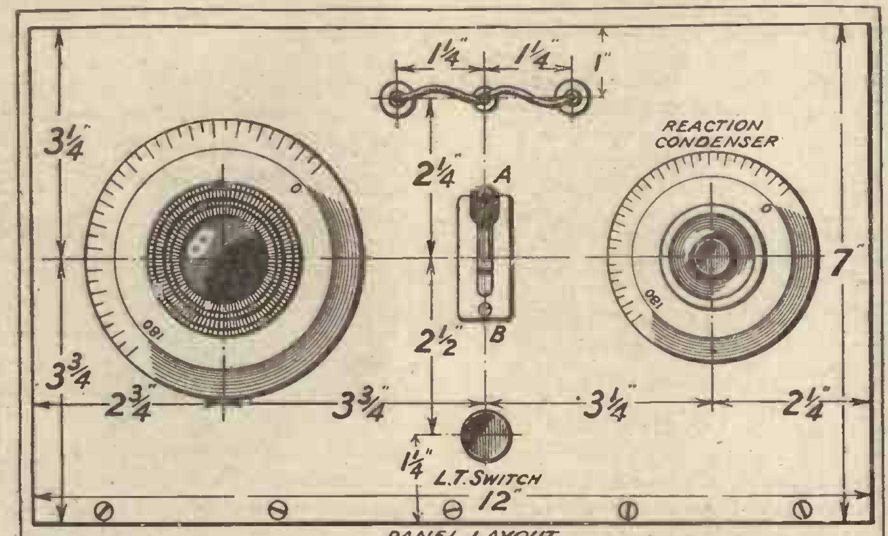
Tabulated elsewhere in the article is a complete list of the components required, and although certain makes are mentioned, it should be clearly understood that these are by no means the only suitable types. The intending constructor would do well to go through the advertisements in this issue, choosing components that are most suitable both to fancy and pocket.

With the components to hand, the constructional work can be commenced, and, following the usual line, the panel is the first item to receive consideration. This should be marked out in accordance with the layout diagram, and then drilled. To preserve a good front-of-panel appearance all markings should be made



The aerial system employed gives selectivity in tuning without unduly sacrificing signal strength.

on the reverse side of the ebonite. The following may seem a somewhat obvious warning, nevertheless, it is easier to read a sentence than it is to fill unwanted holes with heel-ball.



PANEL LAYOUT.

When marking the panel on the reverse side, be careful to copy the layout diagram also in a reverse order.

There is no heavy weight to be supported on the panel, and for this reason panel brackets were omitted. It was found that ample support was obtained by the use of reasonably long wood-screws.

To add to the set's appearance, the hole in the panel through which the reaction leads pass can, if desired, be fitted on each side with a coloured bush such as is obtained from a Clix socket.

Now follows the mounting of the panel to the baseboard, and this should not be a very difficult job. Before finally securing the various baseboard components, it is best to secure the two terminal strips to the back edge. There are only seven components on the baseboard, and the exact positions of these are given in the back-of-panel drawing, which is to scale.

Easily Wired Up

The wiring of the set is simple, and all the guidance needed can be obtained from the wiring diagram and the list of point-to-point connections.

Let me here reiterate the previous warning about the wiring to the switch. It is certainly not difficult, but at the same time failure to wire it up exactly as shown may result in an untimely end to the valve when the set is first tested.

With regard to the flex leads from the reaction coil holder, these terminate at the front of the panel in Clix plugs, as will be apparent from the front panel photographs.

The "X" coil intended for use in the set is provided with two tappings, both of which give a fairly high degree of selectivity, that is, as far as one-valvers go. In some cases this degree of selectivity may be unnecessarily high, and since the attainment of selectivity is to some extent at the expense of signal strength it was thought advisable to make provision for increasing the signal strength by the introduction of an additional aerial coupling winding. This takes the form of a coil wound to approximately the same diameter as the "X" coil, and consisting of fifteen turns of No. 22 or 24 D.C.C. wire. When finished, this coil should be tied to the "X" coil, but not in a permanent manner, since the correct direction for the additional coil will have to be determined by experiment when the set is tested.

Regarding the two ends of this winding, one should be connected to the highest tapping point on the "X" coil, while the remaining end should be joined to the flexible lead from the aerial terminal.

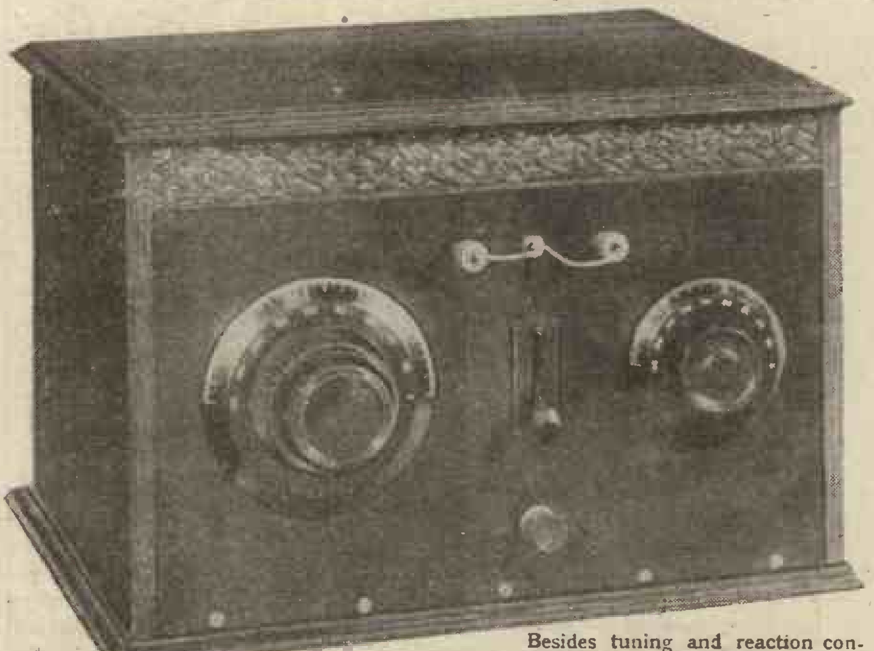
Suitable Valves

To my way of thinking, the most interesting part of the procedure is undoubtedly that of testing the set, and it is to this operation that we now turn.

Insert in L_1 the "X" coil, to which the extra winding has been tied. The correct size for the "X" coil will probably be found to be a No. 60 or 75. For L_2, the reaction coil, a No. 35 or 50 ordinary coil will meet the case.

The set is suitable for use with 2-, 4-, or 6-volt valves as desired, and the choice is left to the reader. With regard to the types of valve most suitable, in the 2-volt series one suitable for H.F. or detection should be used, while in the 4- and 6-volt types a high-frequency valve also is to be preferred.

With the batteries, 'phones, aerial, and earth all joined up to the set, place the tuning dial at zero and increase the capacity of the reaction condenser until the set commences to oscillate. This condition can be recognised by a rushing sound in the telephones. Now decrease the



Besides tuning and reaction controls, the set is provided with an on-off switch, reaction change-over device, and two plugs and sockets to reverse the reaction connections when necessary.

capacity of the reaction condenser until the set ceases to oscillate, and find the settings of G_1 (tuning condenser) at which the local station and 5 G B are heard. Make a note of these two settings and on no account bring the set into oscillation at either of them, as by so doing considerable interference is liable to be caused to neighbours. Carefully observing these two points, next determine whether the set will oscillate over the whole range of the tuning condenser.

If no reaction effect is obtained the two Clix plugs on the panel should be reversed, and if this fails to bring about the desired effect, the H.T. voltage should be increased.

It is of little consequence which circuit is tried first, but before changing from one to the other, the reaction condenser should always be placed at zero.

WIRING IN WORDS.

Join E terminal to pin of L_1 coil base, to L.T.+, to moving vanes C_1, to one side of L.T. switch and to contact No. 1 on switch. Join socket of L_1 coil base to one side of grid condenser and leak and to fixed vanes C_1.

Join remaining side of grid condenser and leak to "G" terminal of V_1.

Join P terminal of V_1 to contact No. 5 on switch. Join contact 2 on switch to fixed vanes of reaction condenser, to one side of H.F. choke and to contact 7 on switch.

Join contact 3 to contact 8 on switch and also to left-hand Clix socket.

Join remaining Clix socket to contact 4 on switch.

Join moving vanes of reaction condenser to contact 6 on switch.

Connect contact 9 on switch to remaining side of H.F. choke, to one telephone terminal and to one side of telephone condenser.

Join remaining side of telephone condenser to remaining telephone terminal and also to H.T.+.

Connect H.T.— to L.T.— and also to one filament terminal on valve holder.

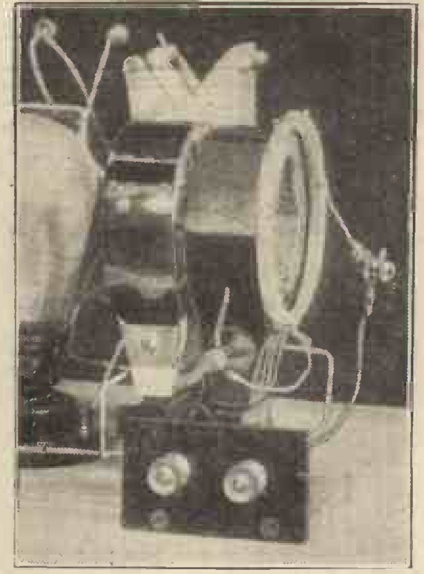
Join remaining filament terminal on valve holder to one side of filament resistance. Connect remaining side of filament resistance to screw-on rim of L.T. switch.

A flexible lead should be joined to terminal A, the remote end of which lead should be equipped with a spade tag.

Join two flex leads to the reaction-coil holder and pass them through the hole in the centre of the panel.

DX Reception

When searching for distant stations, it should be borne in mind that the most sensitive condition of the set is just *below* the oscillating point. For success in logging stations, the approach to this condition must be gradual and smooth, and if there is any suspicion of a "plop" adjustments should be made to the H.T. battery and size of reaction coil until the "plop" disappears.



Note the home-wound aerial coil coupled to the "X" type grid coil.

It should be observed that the setting of the reaction condenser at which the set is just below the oscillating point will vary with different settings of the tuning condenser.

The set has been well tested both in London and at a point about ten miles out.

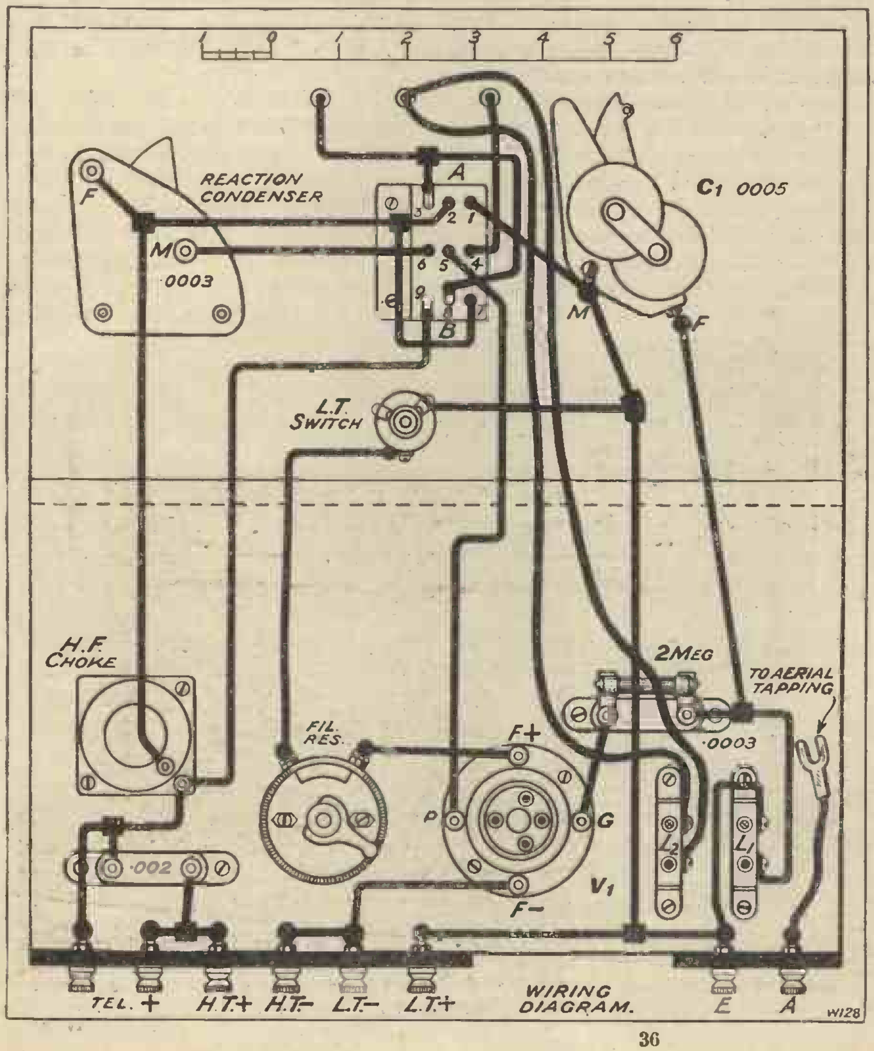
In cases where it is only desired to receive the local station, an ordinary plug-in or centre-tapped coil can be used. With a centre-tapped coil the flexible lead from the aerial terminal should be connected to the centre-tap, but when using a straightforward plug-in coil the flex lead should be joined to the side of the grid condenser remote from the grid.

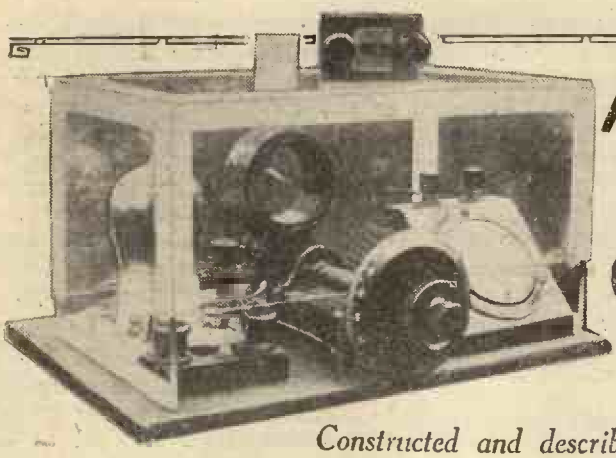
At the latter test, which was conducted under what might be termed average conditions, many stations apart from the local and 5 G B were heard at fair telephone strength. Among those identified may be mentioned in particular Langenberg, Frankfurt and Radio Toulouse.

On the Long Waves

The set was also tried on the long-waves with satisfactory results. For this test a No. 250 "X" coil was used for L_1 and a No. 150 ordinary for the reaction coil. This latter figure should not be taken as fixed, since it may be found that a larger (or smaller) coil is required in some cases.

As to results, the long-wave Daventry was heard at quite pleasing strength, and it was not a difficult matter to tune in Radio Paris at fair strength.





A QUARTZ CRYSTAL OSCILLATOR

An instrument which will prove invaluable to the experimenter.

Constructed and described by E. J. SIMMONDS, M.I.R.E., F.R.S.A.

A VERY important and far-reaching application of quartz crystals to radio engineering is as standards of frequency. An oscillating crystal whose fundamental has been accurately determined by careful calibration becomes not only a standard of wave-length always preserving the original accuracy of calibration (which may be within 1 part in 100,000) but also a standard from which wave-meters may be calibrated over a wide band of wave-lengths, using as plot points the abundant harmonics of the fundamental of the oscillating quartz, when set up with suitable circuit arrangements.

An Unvarying Standard

Even the most expensive wave-meter cannot be expected to hold absolutely to the original calibration over a long period, but if a calibrated quartz oscillator is installed, the worker has available an unvarying standard by which the accuracy of the wave-meter can be readily checked at any time.

An instrument of this type now to be described has been in constant use in the writer's laboratory for a considerable period, and has proved invaluable. Fig. 1 indicates the general scheme of the circuit used, and it will be noted that a heater unit fed from the filament battery is fixed in the base of the bakelite crystal holder—a thermometer is also attached to the crystal holder—and by operation of the heater unit it is possible to bring the quartz to any predetermined temperature. This refinement is considered necessary as the natural response frequency of quartz varies with a change in temperature, and it is therefore necessary to bring the quartz to the same temperature obtaining when the original calibration was made.

Different specimens and cuts of quartz plates vary greatly in the frequency shift with a change in temperature, and those specimens exhibiting the most vigorous piezo electric effect usually show the greatest frequency change for a given variation in temperature.

The details of the crystal holder and heater unit are clearly shown in the sectional drawing, Fig. 2. The holder may be conveniently made from four layers of bakelite, as this will facilitate cutting out the square hole to take the quartz crystal and brass top and bottom plates.

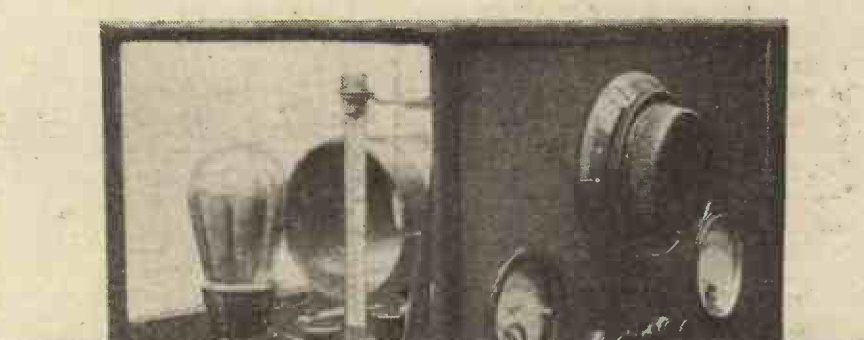
No dimensions are given, as these will depend upon the size of the quartz crystal. It is therefore advisable to obtain the finished quartz first, and the box can then be made to fit. Suitable crystals can be obtained from Mr. A. Hinderlich, of 1, Lechmere Road, Willesden, who makes a speciality of the production of quartz plates for all frequencies. The brass top and bottom plates should be approximately 1-10th inch thickness, and fit snugly into the bakelite holder without any appreciable shake. They must not, however, fit tightly in any position, or the crystal may refuse to build up into oscillation.

The faces of the plates touching the quartz must be ground smooth and dead flat, and a light curved spring of No. 30 gauge spring brass, $\frac{1}{4}$ inch wide, presses lightly on the top brass plate, thus obviating any shake of the components.

The Temperature Control

The heater unit consists of four inches of No. 33 Eureka resistance wire, 3 ohms resistance, wound on a former of sheet mica rolled up into a small tube, $\frac{1}{4}$ inch diameter. The interior of the chamber in the base of the holder should also be lined with sheet mica attached by shellac varnish.

The thermometer indicating the temperature of the crystal may be of the type commonly supplied by dealers in chemical apparatus, and should be calibrated in degrees



The complete oscillator has a neat and businesslike appearance, as may be judged from this photograph.

centigrade, since that system is generally used in all scientific work. The type of bath thermometer in metal cases about six inches long may also be used, but these are usually calibrated in degrees Fahrenheit, which will necessitate conversion to the centigrade system.

A point to be decided is the frequency of the quartz crystal to be used. If the crystal standard is

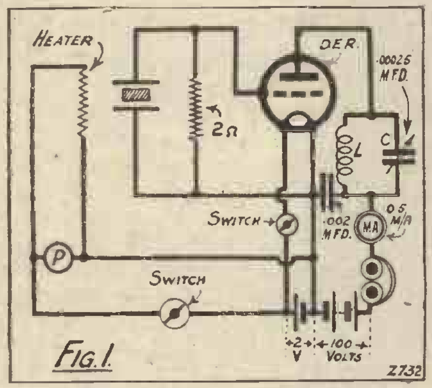


FIG. 1

required to give check points in the broadcast band, a quartz crystal of approximately 100 kilocycles (say, 3,000 metres) should be chosen, while if checks on the shorter wave-lengths (15 to 100 metres) are required, a crystal having a fundamental of approximately 500 kilocycles will be more suitable.

Referring again to scheme of connections, Fig. 1, it will be noticed that a D.E.R. valve is used fed direct from a 2-volt accumulator, thus obviating the necessity for a filament rheostat. A valve of this type has a comparatively thick filament, with ample emission and long life, and is particularly suited for the conditions. It is absolutely necessary to include a milliammeter (M.A.) in the H.T. lead, and the range of this instrument should be 0·5 milliamperes.

The readings of this instrument are a valuable guide that the crystal is oscillating correctly, as will be shown later.

The variable condenser C calls for no special comment as so many good condensers of various makes are now available.

"Vigorous Oscillation"

The inductance L should be wound single-layer solenoid form of No. 28 S.W.G. silk-covered copper wire on a paxolin tube 3 in. diameter by 3½ in. long, the number of turns depending upon the value of capacity C and the fundamental of the quartz plate used.

As an indication of the number of turns required, the instrument used by the writer employs a quartz crystal having a fundamental of 508 kilocycles (590 metres), and L has 130 turns giving 785 microhenries, the capacity of C being 102 mmf.

The following method should be adopted by the constructor to find the correct number of turns. Set the dial of condenser C at, say, 40 or 50 deg., and then vary the number of turns on L to give the lowest reading of anode current as indicated by milliammeter (M.A.), consistent with vigorous oscillation of the quartz.

When the number of turns have been properly adjusted, the following fluctuations of anode current will be observed. When the valve filament is switched on, the anode current will *momentarily* rise to a comparatively high value, say, 5 milliamperes, and as the valve filament comes up to full emission the anode current will drop *sharply* to a minimum of approximately 1½ milliamperes, thus indicating the condition of vigorous oscillation.

The Pilot Lamp

The construction of the heater unit has already been dealt with, but it should be noted that a pilot lamp is included on the front panel to indicate when the heater is switched into circuit. The pilot lamp may consist of a 2·5-volt flash lamp connected on the heater side of the switch as shown.

The grid leak is an ordinary receiving type, having a valve of 2 megohms, and it is unnecessary to use a grid choke with a crystal of comparatively long wave-length. This completes the constructional details of the instrument, and it should be fitted with a suitable case to exclude the dust.

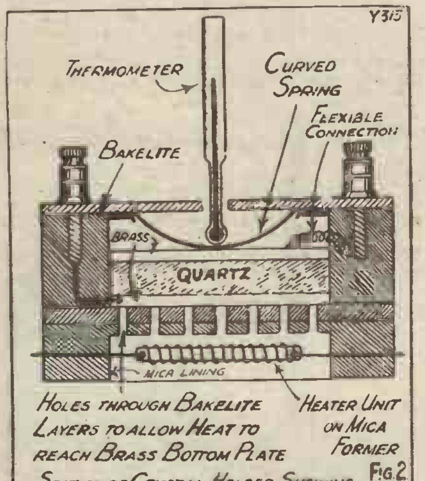


FIG. 2
SECTION OF CRYSTAL HOLDER SHOWING ARRANGEMENT OF HEATER & THERMOMETER.

Regarding the important point of calibrating the quartz crystal, two courses may be adopted. Either a crystal with National Physical Laboratory certificate may be purchased, or the complete crystal, box and holder may be forwarded to National Physical Laboratory, when a report will be furnished giving the exact frequency of the crystal and the conditions under which the calibrations were made, the latter alternative being the cheaper course to adopt.

Calibrating a Wave-meter

If the crystal is sent for calibration to N.P.L., it is necessary to specify that calibration is required as an oscillator, not as a resonator.

We may consider briefly the procedure to be adopted in calibrating a heterodyne wave-meter from the quartz standard, supposing, for example, that we are using a crystal with a fundamental of 500 kilocycles (600 metres).

Having started up the quartz oscillator, arrange the wave-meter and quartz standard with a separation of at least 2 feet, to ensure a loose coupling. Telephones should be plugged either into the crystal oscillator, or the wave-meter, and the approximate setting of the condenser on the wave-meter for 500 kilocycles should already have been ascertained. Now with both instruments oscillating, vary the tuning of the wave-meter around 500 kilocycles, listening carefully for a beat note.

As the wave-meter frequency approaches the frequency of the oscillating crystal, the usual beat note will be heard in the telephones, until the zero beat position is reached, indicating that the wave-meter is exactly in resonance with the quartz. Zero beat position is attained when the two oscillators (quartz and wave-meter) are beating with each other, but so nearly in resonance that the difference in the two frequencies produces a resultant beat note which is below audibility.

Plotting a Scale

To each side of this position an audible note will be heard rising rapidly in pitch as the two oscillators depart from synchronism.

We have now the wave-meter adjusted to exact resonance with the calibrated quartz, and we may mark this point on the wave-meter scale as 500 kilocycles or the equivalent wave-length in metres.

We may now proceed to plot further points on the wave-meter scale, by carefully searching downwards in wave-length for the harmonics of the *fundamental* of the quartz oscillator, observing that these harmonics will occur at intervals of 500 kilocycles, and that they are all integral parts of the fundamental. Thus harmonic No. 2 (300 metres) will be heard when the wave-meter is tuned to 1,000 kilocycles, harmonic No. 3 at 1,500 kilocycles, or 200, and so on. Note also that the second harmonic gives a point exactly half the fundamental wave-length of the crystal, and the third harmonic is one-third of the crystal fundamental, and so on.

Secondary Harmonics

All these points should be plotted on squared paper, and every care must be used to avoid missing any of the sequence of the harmonics. It should be quite easy to go down to the twentieth harmonic of the crystal, and the accuracy of the plotting will be confirmed by the regularity of the points on the squared paper.

Care must be taken to tune to the zero beat position (already explained) at each harmonic, and it will be a very material assistance if the approximate range of the wave-meter is known beforehand, because in the process of searching for the integral harmonics of the quartz oscillator other weak beat notes will be encountered, which are therefore likely to be misleading unless the approximate wave-meter range is known. These secondary harmonics are caused by the harmonics of the *crystal* oscillator beating with harmonics of the *wave-meter*, and thus producing a *resultant* frequency.

A Weak Beat Note

For example, suppose we are using a quartz crystal with a fundamental of 600 kilocycles, and the wave-meter is tuned to 400 kilocycles.

In the telephones we shall hear a weak beat note which is not an integral part of the crystal fundamental, but is caused by the wave-meter second harmonic (200 kilocycles) beating with the third harmonic (200 kilocycles) of the quartz oscillator.

We have thus obtained a plot point at two-thirds of the frequency of the quartz, and in like manner a great variety of combinations of fractional harmonics can be obtained, which will give useful points to fill in the spaces between the integral harmonics. It is, however, most important to carefully plot the integral harmonic points *before* undertaking serious search for these fractional harmonics.

By this method, with the exercise of patience and care, we can accurately calibrate any heterodyne wave-meter, and always have available an unvarying standard to which we can periodically refer the wave-meter for checking purposes.

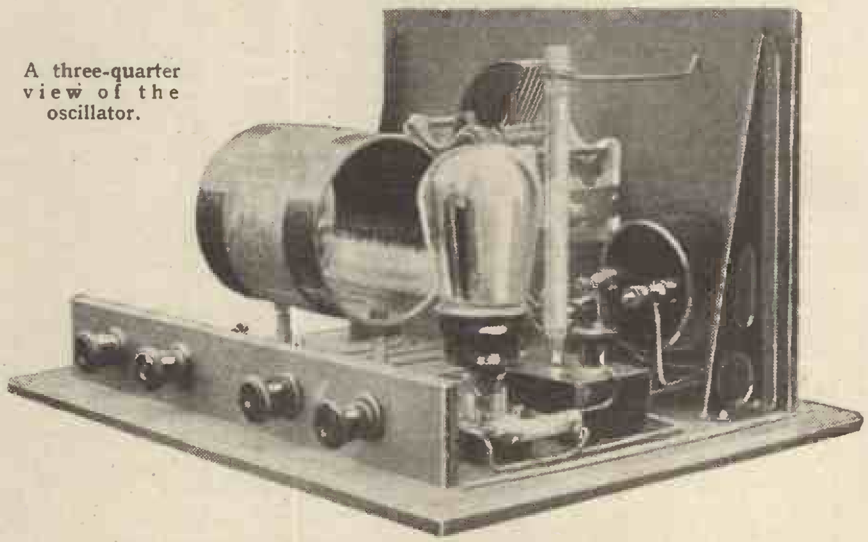
If it is desired to calibrate a wave-meter of the absorption type, it will be necessary to use an oscillating receiver to give the beat notes with the crystal oscillator, using the same method as described, and as each harmonic point is found on the receiver, the relative reading for the absorption meter can be found by listening for the usual sharply defined click which will be heard in the receiver telephones as the absorption meter is tuned through the resonant point.

Has Many Uses

However, the accuracy of the absorption meter does not compare with the exactness of a heterodyne meter. If it becomes necessary to calibrate any type of absorption circuit, it is more convenient to use a small continuously variable generator or valve oscillator in place of the receiver. Such an instrument was described by the writer in MODERN WIRELESS for March.

This type of oscillator has many uses in a radio laboratory outside of calibration work, and embodies a very valuable visual form of resonance indicator, viz., a grid milliammeter.

A three-quarter view of the oscillator.



The support for the thermometer is clearly seen, together with the anode coil and tuning condenser.

THE EXPONENTIAL LOUD SPEAKER

GREAT results are predicted for the "exponential" loud speaker which has recently been developed by the Research Laboratories of the Westinghouse Electric and Manufacturing Company. An "exponential" horn is best described as a horn the cross-section of which doubles for equal increases in length. For example, if a horn has an orifice ½ square inch in section at the small end, and at 1, 2, 3 feet, etc., from this end the cross-sections are 1 square inch, 2 square inches, and 4 square inches respectively, we have an exponential horn in which the area doubles every foot. A horn whose area doubled at smaller intervals would be said to expand more rapidly and one in which the area doubled at longer intervals would be said to expand more slowly. The rate of expansion is an important factor in horn design, for it determines the lowest frequency down to which the horn is a uniform radiator. A horn in which the area doubles at every foot cuts off at 64 cycles; one expanding half as rapidly cuts off at 32 cycles, and one expanding twice as rapidly cuts off at 128 cycles.

The advantages of this new type of horn in high-power reproduction are claimed to be (1) it allows the use of relatively small and easily constructed vibrating systems, and (2) it makes for high efficiency, thereby reducing the size and cost of amplification for operating the loud speaker.

WHAT READERS THINK

Loud-Speaker Impedances

SIR,—I cannot let Mr. Leon E. Newnham's letter, which you print in this month's MODERN WIRELESS, pass without comment, especially as his suggestion as to the proper resistance of a loud speaker for use with a 2,000- or 3,000-ohm valve is, I venture to think, very wide of the mark.

First, let me say, begging Mr. Newnham's pardon, that I was not confusing my terms. I was surprised when my rough measurement of the impedance of my Lissenola gave 1,850 ohms when the resistance is supposed to be 2,000 ohms, and that is why I added that the matter required further investigation.

Having now got some rather more refined apparatus set up, I repeated my measurements the other day, and the figures I get are as follows:

Direct-current resistance of Lissenola under test, 1,900 ohms.

	Cycles	Ohms
Impedance at frequency of about	5	1,900
" "	50	1,950
" "	64	2,000
" "	128	2,150
" "	256	2,800
" "	475	4,000

N.B.—There was no direct current in the Lissenola windings, and the A.C. voltage was about 5 volts R.M.S.

I have no reason to suppose these figures are not right, at any rate to within 10 per cent or so, though they vary to some extent according to the adjustment of the reed in relation to the magnets, but at the same time, if any of your readers can give me corroboration or otherwise, I should be interested to have it. All Lissenolas should give figures of the same order of magnitude.

It is seen from these figures that the impedance does not become double the resistance until a frequency well above middle C in the musical scale is reached, while for all bass notes the resistance is responsible for by far the greater part of the impedance, and that therefore a valve whose resistance is equal to the resistance of the loud speaker will deliver maximum power on the low notes, where maximum power is wanted.

Yours faithfully,
A. K. GORDON, M.A.

Blundellsands,
Liverpool.

L.T. Economy

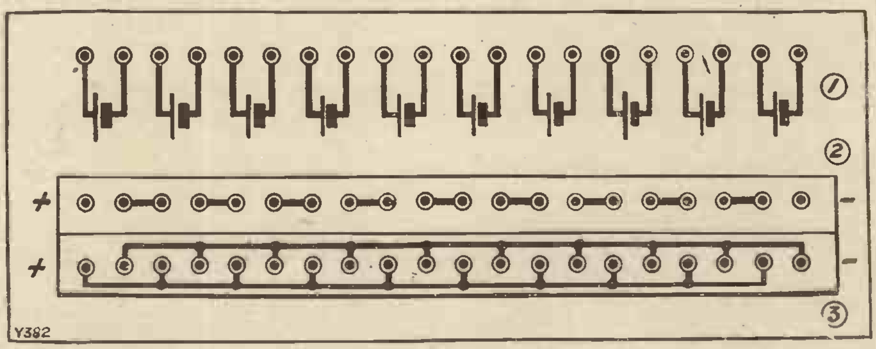
SIR,—Having read Mr. Dowding's interesting article on L.T. Economy, and noted his switching arrangement for a 60-cell 6-volt battery, the following arrangement suggested itself to me as being somewhat easier to wire.

If each ten cells are connected to a row of valve sockets as (1), and the same number of valve legs are fitted to a strip of ebonite and connected as shown (2), when plugged in the cells will be in series, but, if connected as (3), will be in parallel.

Of course, it is not so easy as moving a switch, but is easier to construct.

Yours faithfully,
J. KUFFEX.

Westcliff-on-Sea.



Empire Broadcasting

SIR,—After reading your reply to Captain P. P. Eckersley in reference to Broadcasting and the Empire in the September issue of the MODERN WIRELESS, I thought it might interest you to hear from a reader of your excellent paper who is resident in the most distant part of the British Empire.

I get, as many others do in N.Z., the Dutch Station P C J J every Wednesday and Friday morning, and now that I have added a third stage of audio we hear music from this station consistently for about one hour on the loud speaker with enough volume to be heard at the most distant part of the house; after about 7 a.m.(N.Z. time) the volume decreases very rapidly and by 7.30 a.m. is only just audible.

On Wednesday morning last we enjoyed one hour of London relayed by P C J J; the time was Tuesday, October 18th, 18–19 G.M.T. (5.30–6.30 a.m., Wednesday, N.Z. time).

Big Ben Heard

The first heard was Big Ben striking 6 p.m.—*the first time heard in New Zealand;* this was followed by the London Radio Dance Band giving a number of foxtrots for half an hour, after this weather forecast, news, etc., and fifteen minutes of the Daventry Quartet.

My wife and self have been away from the "Old Country" for twenty years, so you can imagine how we enjoyed being back home for one hour. There are thousands like us who would rise earlier than usual for the sake of listening to speech and music from home.

The set I am using is the "Australia on Two Valves," by Percy W. Harris, built by me about last Easter. I have logged, so far, 25 short-wave stations, all on telephony, the most distant ones are:—P C J J, U 2 X A F, U 2 X A D, K D K A, W L W, R F N, 4 N W, 2 N M (Marcuse), 4 A C (Belgium), and a foreign station the call of which sounds like "Labortorum Radioesque Belgique," also another foreigner who I think is R C B 8 (Buenos Ayres). The balance are Australian and New Zealand stations.

Yours faithfully,
F. W. SELLENS.

Wellington,
New Zealand.

TELEVISION. SOME FACTS & FANCIES

by the Editor

For the last two years the general public has been encouraged to regard radio television, or the wireless transmission of far-distant scenes, as a project that is on the verge of practical achievement in a commercial form.

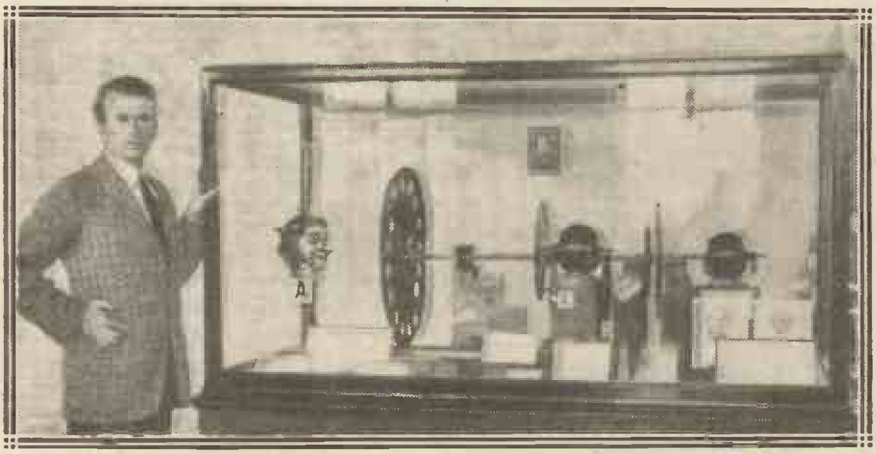
The broadcasting of distant speech and music, they argue, has now been developed to a point that is little short of perfection. That being so, the difference between hearing and seeing across a continent should not be so great as to baffle the resources of modern science.

Promises Unfulfilled

This line of argument may be comforting to the optimist and flattering to the scientist, but it has little foundation in fact.

During the past year a company has been floated for the purpose of establishing a television service designed to allow distant scenes or pictures to be reproduced by a simple type of apparatus suitable for home use. Thirty pounds was quoted as the figure at which the Television receiver could be marketed, and Christmas, 1927, as the date by which the scheme was to be in operation.

At the time of writing neither of these promises has been fulfilled, nor is there any substantial indication that they are likely to be attained in the immediate future. It is true that certain demonstrations have been given of the transmission, under restricted conditions, of what may euphemistically be called "moving effects." But there is as yet no sign of the establishment of a broadcast service of pictures likely to prove of general interest or utility, nor of the



Mr. Baird and the television outfit he presented to the South Kensington Science Museum.

Mr. Baird stands alone amongst British inventors in having definitely promised to bring television within the reach of the man in the street by the end of 1927.

To be a commercial success, such a television service should be capable of bringing into the home not only the features of some distant person, but also a representation of far-off events actually in progress, such as a prize fight or a football match, or a tennis tournament, on at least the same scale and with equal clarity to that given by the small kinema projectors now on the market.

The Baird Company presumably aims to provide a service on these lines. Otherwise the general public are hardly likely to be interested in the project.

Up to the present no public demonstration of successful long-distance radio television has been made by the Baird Company. It is true that moving effects representing a person's features have been secured, but it is by no means clear that these effects were transmitted by wireless.

Similar results have previously been claimed by other inventors both in America and on the Continent, but they have not been so rash as to promise a comprehensive scheme of television reception on a standard set priced at £30.

The most successful television experiment on record cost the American companies concerned several thousand pounds and the services of over a thousand men to reproduce clearly a single person's face on a scale of two inches by three. This, it must be admitted, is very far removed from the stage of commercial exploitation.

So far as can be ascertained, Mr. Baird claims to stand head and shoulders above all other workers in television, partly because he has discovered a new light-sensitive cell, which was first announced two years ago, but the composition of which still remains a secret, and partly because he uses a special method of illuminating the object to be transmitted.

Otherwise he appears to work on the same general lines as Jenkins, Belin, Alexanderson, Karolus, and many others.

So far as the sensitive light-cell is concerned, the merit of this discovery can only be judged by results. As regards the use of infra-red rays in place of more highly actinic light, it would appear on first principles that this must inevitably reduce the effective light-intensity and prejudice clarity of reproduction, particularly for long-distance working.

Without making any unfair criticism of the work done by Mr. Baird, we would point out that the time is ripe for some clear and convincing demonstration of the value of his promises. Can he, for instance, televise the Boat Race, or even a theatrical show?

In short, we ask Mr. Baird to answer these questions:

1. Does he propose to start a Television service from 2 T V, and, if so, when?

2. Does he propose selling Television Receivers at £30?

3. Assuming that the price of his home receiver is £30, what size of picture can be reproduced by this apparatus? Will the price of the receiving set cover a reasonable service of topical events, or will this be subject to a special subscription fee, and, if so, how much?

It is up to Mr. Baird to answer these questions.

appearance of a £30 receiver capable of reproducing a "living" picture worth looking at.

In connection with this scheme newspaper reports have from time to time been published describing the "audible" results of presenting a picture to the television transmitter. It may be interesting to some people to "hear" the disturbance caused by So-and-So's face when projected on to a light-sensitive modulator, but it is not television. The same kind of noise could be produced merely by knocking the microphone about in a broadcast studio.

Demonstration Required

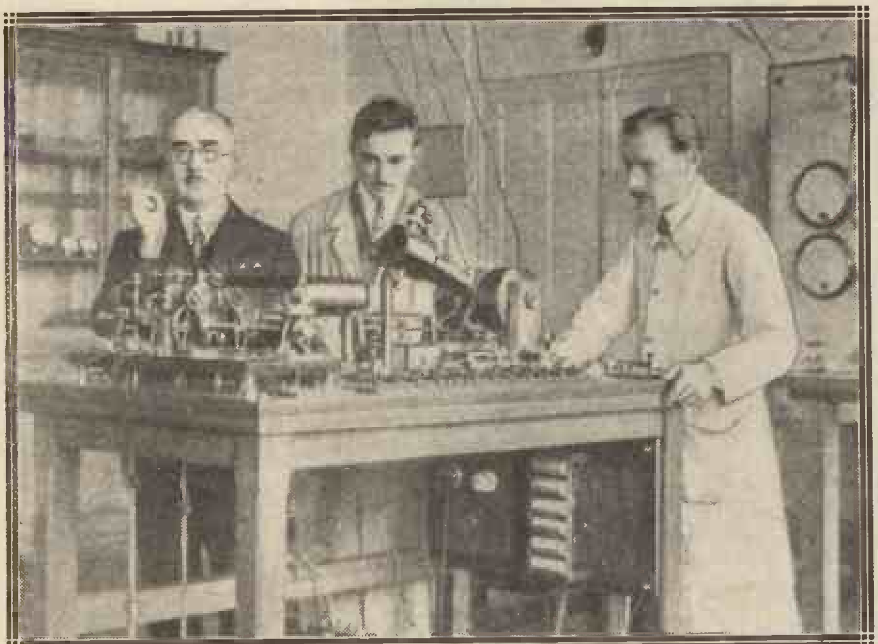
What is required to restore public confidence is a demonstration, open to the general public, of the visual reception of moving events televised by wireless, say from France or some other distant locality, where there is no possibility of a wire connection.

Tentative Results

In America tentative results have been secured by Jenkins, who uses a system of rotating lenses, and by Alexanderson, with rotating mirrors and several distinct light sources in place of one. It is interesting to note that even with this improvement a ray from each of seven separate light-sources must strike the screen more than 40,000 times per second to produce a reasonable clarity.

Belin, in France, has also transmitted moving effects between a transmitter and a distant receiver by using a vibrating-mirror analyser, the two stations being linked together by a connecting wire. There are many others on the Continent working along the same general lines, amongst whom the names of Mihaly and the Telefunken Co. may be mentioned.

It is probable, however, that the only convincing demonstration that has ever been given of distant television effects was that carried out between Washington and the Bell Telephone Laboratories in New York early in 1927. Here the reproduction of a speaker 200 miles away was clearly shown on a screen measuring 2 in. by 3 in. When it was attempted to enlarge the picture to measure 2 ft. by 3 ft. for auditorium use, the definition became blurred and was practically lost.



M. Edouard Belin (left) at work on his television scheme in his laboratory at Malmaison.

In this case success was only made possible by the use of telephone wires connecting the transmitting station with the receiving apparatus. Similar effects were, however, secured by radio, without any connecting wire, over a distance of 30 miles only. The cost of the apparatus ran into many thousands of pounds, a figure far too high for general commercial use. In addition, for the long-distance wire transmission the services of nearly one thousand men were required to ensure success.

One of the outstanding difficulties is that of securing sufficient reflected light from the person whose features are to be transmitted. It is comparatively easy to transmit simple shadow or silhouette effects, because here the sensitive cell has only to respond to the difference between full light and complete shade.

To transmit details of the features or expression, it is essential to use light *reflected* from the face of the sitter, and this is, in general, only one-thousandth the intensity of the incident ray. The response of the sensitive cell to reflected light is, in fact, found to be so small that for the 30-mile wireless transmission it became necessary to amplify it five thousand billion times in order to get it across the ether.

Varied Proposals

The tremendous gap which separates ordinary broadcasting from wireless "vision" can perhaps best be illustrated by setting out briefly the general principles involved.

The problem of television covers broadly any device whereby a distant scene, normally out of the range of sight, can be presented to the eye. To some extent a telescope falls within this definition, but with a telescope it is obvious that the object to be viewed must be in a straight and unobstructed path from the observer.

Another alternative is the ordinary camera. The scene is first fixed by photographic means, and can then be transported. True, the camera can only reproduce a still-life scene, but this limitation has now been removed by the art of the kinema.

It has also been proposed to use the phonograph to record visual scenes, as follows. Light sensitive cells are first employed to produce a hill-and-dale tracing corresponding to the various light and shade effects of the scene. From this tracing the picture can then be reproduced at any distant place by (*a*) causing the record to vary the intensity of a source of light, and (*b*) providing means for suitably projecting this varying light on to a viewing screen.

"Still-Life" Transmission

Still another scheme is the one which is often confused with true television. A still-life picture or photograph is telegraphically transmitted by sending out a series of dots and dashes or lines, so co-ordinated that they build up the appearance of the original picture. This method has for some time been used commercially for the rapid transmission of topical scenes required for immediate reproduction in the newspapers.

It was first invented nearly 50 years ago, in connection with ordinary telegraphy or signalling over line wires, where the difficulties of accurate synchronization are much less than when the ether is the only connecting medium. During the past year, however, it has been successfully adapted for true radio transmission without wires, and is now in constant operation between Europe and America.

A Significant Point

The significant point about telephotography, as distinct from television, is that it takes from ten to fifteen minutes to transmit a small picture and costs roughly £1 per minute to do so. When one recalls the fact that successful television necessitates the reproduction of at least ten to fifteen complete pictures in each second, one gets an insight into the difference between what has been done on a commercial basis and what remains to be done before long-distance radio television can reach the final stage of success.

True television differs from the schemes that have been previously mentioned because it implies substantially simultaneous transmission and reception of the picture as a whole. In this respect it may be said that broadcasting is related to the gramophone in much the same way as television is to the kinema.

This requirement of simultaneity is bound up with enormous difficulties, chief amongst which are those associated with the problem of synchronizing or keeping the transmitter and receiver in step with each other. This point will be better appreciated when the actual mechanism of transmission and reception has been sketched out.

Synchronising Problems

One notable exception may be mentioned. It is a scheme due to Fournier d'Albe, and was awarded first prize in a £500 television competition held some time ago by the "Wireless Review" (now amalgamated with "Popular Wireless"). In this system the necessity for synchronization between the transmitter and receiver was avoided by using banks of tuned resonators, but unfortunately the method has not since proved capable of producing sufficiently clear results to justify commercial exploitation.

In practically all other known systems, the transmitting and receiving devices must be run at very high speeds and maintained in absolute synchronism, otherwise reproduction is completely blurred.

The process of transmission consists in projecting reflected light from successive elemental areas of the picture or scene on to a light-sensitive cell, which converts its "impression" of each successive light and shade effect into a corresponding electric current. This is then used to modulate a carrier wave. In short, the light cell plays the part of the microphone in wireless telephony.

The splitting-up of the picture into a large number of small elements is termed "exploring" or analysing. At the receiving end this process is reversed, and the various current impulses, corresponding to each separate picture-element, are combined to create transient light effects which, when viewed by the eye, gives the impression of the original picture. This is termed synthesizing.

For Smooth Reproduction

Now, in order to give a pleasant and identifiable picture, the picture elements mentioned above must be closely grouped together as in ordinary process printing. Unless there are at least sixty in each square inch, the picture will be too coarsely grained to be recognisable.

Let us assume that it is desired to televise a scene on a square screen, say, of 10 in. side. Anything much less would hardly interest the ordinary man in the street. This means an area of 100 square inches, or a minimum of 100 × 60 elements.

Accordingly, the process of transmission involves a moving device capable of separately exploring 6,000 elements and converting each element into a corresponding electric current. It must also be able to repeat this complete survey at least ten, and preferably fifteen, times per second, so that the minimum number of signalling impulses grows to 60,000 per second. Anything less than ten repetitions per second will not give a smooth reproduction free from flicker.

The experimental television apparatus constructed by Mihaly, the Hungarian scientist. To televise this picture with its present detail but with a considerable amount of "flicker" would require a *minimum* of nearly 1 million *synchronised* impulses *per second*. A RADIO FREQUENCY!

Analysing the Picture

At the receiving end the same number of elements must be reconstituted by the received signals through the medium of a suitable source of variable light (which in reception takes the place of the light-sensitive cell in transmission). What is more, the light so varied must be projected either on to the retina or a viewing screen under the control of mechanism which must move in absolute step, i.e. be accurately synchronized with the exploring device used at the receiving end.

Supposing that it is possible to explore the minimum of 60,000 elements in one second by some means at the transmitting end, the outstanding difficulty is to run the building-up device at the receiving end at identically the same speed. Unless the two devices move accurately in step, i.e. maintain the same speed, and in addition keep absolutely in phase with each other, overlap takes place and the reproduction is blurred out of all recognition.

The simplest method of analysing the picture for transmission is to pass a perforated strip between the brightly illuminated view (or an optical image thereof) and the light-sensitive cell, the perforations being "stepped" as shown in the sketch, so that the pencil of rays incident on the cell traverses the view transversely as well as longitudinally. The same result can be secured by using a rotary disc with a spiral series of holes, the distance between the innermost and outermost hole corresponding to the width of the picture.

Another expedient is to utilise two vibrating mirrors, one scanning the object from top to bottom, whilst the other explores it from side to side. In all such systems a limit is placed upon the maximum speed of exploration by the inertia of the moving parts.

Further Suggestions

To overcome this difficulty, it has been proposed to project the image upon a screen made of electron-emitting material, and to explore this screen by a pencil of cathode rays which will set up currents corresponding to the degree of illumination. Such a system has no inertia.

Baird has also suggested the use of an optical multiplying arrangement of lenses, though in this case it would appear that what is gained in speed of operation is lost by the corresponding diminution in light intensity.

In reception the obvious plan is to cause each current impulse to control the intensity of a Neon lamp or other source of light, and to distribute each " flicker " in its proper position upon a viewing screen, and in such rapid succession that the picture is reconstituted by the effect known as persistence of vision.

Instead of directly controlling the illumination of a lamp, the latter may be kept steady and a Kerr cell interposed between the lamp and the screen, so that the ray is more or less intercepted according to the signal voltage applied across the cell.

Or a cathode-ray may be caused to traverse a fluorescent viewing screen, rendering each spot that it strikes momentarily luminescent, and thus building-up a complete picture, which must, however, be repeated from ten to fifteen times per second before it can reproduce the effect of motion.

A Long Way Off

Synchronism usually depends upon the transmission of a special and distinct carrier or modulation frequency, simultaneously with the signal currents, this special frequency being utilised to maintain phonic or other synchronous motors at the transmitting and receiving ends in step.

Such a method is practicable where there is a connecting wire between the transmitting and receiving stations, but the difficulties are enormously increased when transmission takes place entirely through the ether.

Atmospherics and interfering signals have to be contended with, both as regards their effect upon the synchronising frequency as well as upon the signal components which go to build up the picture. Further, the effects due to fading are such as to form an insuperable obstacle to successful radio vision over long distances.

It is generally admitted that even now the ether is over-congested with existing broadcast services, ships' Morse, and an extensive commercial traffic. Can room be found for a separate television service, even if the outstanding electrical and mechanical problems are overcome ?

Frankly, the present position of wireless television appears from an impartial point of view to be altogether too far removed from practical achievement to justify any expectation of seeing it in the broadcast listeners' home for some considerable time to come.

Mr. C. Francis Jenkins, an American inventor who was one of the first in the field with a demonstration of television.

MOUNTING GRID-BIAS BATTERIES

In some sets the grid-bias battery is mounted on the baseboard. But it should be kept well away from all adjacent leads and components. The casing of the average dry battery is not a good insulator and active leads touching it may short through to the point to which the grid-bias battery is connected.

By the way, it is a far better practice to mount the grid bias on the inside of the cabinet. Here it is well away from all the other components while the leads are taken up well clear of all the other leads. At least one make of grid-bias battery has an ingenious flap incorporated in its construction which allows it directly to be mounted by means of drawing-pins in the position required.

Also, simple brackets are cheaply obtainable which allow the battery to be so fixed. In any case, it is quite a simple matter to fix a small battery in such a position. This procedure is better than having the grid-bias battery outside to add to the number of external leads, and to add to the problem of neat battery accommodation.

The "PURE-POWER" THREE

An efficient loud-speaker receiver capable of providing ample volume with excellent purity of reproduction. It is equally suitable for both ordinary and high wave-length stations.

Designed and described by G. V. DOWDING, Grad.I.E.E. (Technical Editor).

As its name suggests, the ideals aimed at in this receiver were purity and power. It was designed for first-class loud-speaker reception of the local station, 5 G B, and 5 X X. A two-valve receiver will do this, but generally not without using too much reaction. For the three stations mentioned, no reaction at all should be needed except when conditions are very bad. But if you desire to carry out a little D.X. work you will find the "Pure-Power" capable of bringing in quite a few stations. On an average type of outdoor aerial a number of the Germans should come in, and, perhaps, a fair sprinkling of the other Europeans as well.

Popular Circuit Arrangement

The circuit arrangement is an extremely popular one. It consists of a detector valve having Reinartz reaction control, followed by two note-magnifying stages. The first low-frequency stage is resistance-coupled. and the second transformer-coupled. And all the usual refinements, such as separate H.T. leads to each of the valves and separate grid-bias control for the note-magnifying valves, are embodied. A switch is employed which enables one low-frequency valve to be cut out, and I want particularly to draw your attention to the manner in which this is done. In the first place, whether two or three valves are in use, the last valve is always the "last" valve. It is very important that this should be so, and also that it should be of the power type, but I will have more to say about this later on.

With the second valve cut out the receiver becomes a straightforward two-valver, detector and one low-frequency, transformer-coupled; a very popular arrangement, and one that will, in some cases, suffice forloud-speaker reception of the local station.

COMPONENTS REQUIRED

Cabinet, 16 in. × 8 in. × 7 in. deep, with baseboard, brackets, and panel to fit (Artcraft, Bond, Camco, Caxton, Peto-Scott. Pickett, Raymond, etc.).

1 ·0005-mfd. variable condenser, square law or S.L.F., etc., according to preference, with slow-motion or vernier dial. (The one actually used was the new Dubilier. Any good make can be used, since there is ample room on the panel and behind it. A few examples are these: Bowyer-Lowe, Brandes, Colvern, Cyldon, Efesca, Eureka, Forma, G.E.C., Igranic, Jackson, Lamplugh, Metro-Vick, Ormond, Peto-Scott, Pye, Raymond, Utility, etc.).

1 ·00025-mfd. plain type variable (The one used was a Peto-Scott "Minator," but also see above).

1 On-off switch (Ashley, Benjamin, Bowyer-Lowe, L. & P., Lissen, Lotus, etc.).

1 Double-pole change-over switch (parts only, for panel mounting). (Clarke, Eelex, McMichael, etc.)

3 Baseboard rheostats or resistors (Igranic in the set, but any type to suit the valves can be used). (Bowyer-Lowe, Burndept, Burne-Jones, Cyldon, G.E.C., Igranic, Lissen, McMichael, Peto-Scott, C.E. Precision, etc.)

3 Sprung valve holders (Ashley, Benjamin, Bowyer-Lowe, B.T.H., Burndept, Burne-Jones, Lotus, Pye, W.B., etc.).

1 ·0003-mfd. fixed condenser (Clarke, Dubilier, Lissen, Mullard, T.C.C., Ward & Goldstone, etc.).

1 ·0005-mfd. fixed condenser (Ditto).

1 R.C. unit (Carborundum in the set, but see text).

1 ½-meg. grid leak and holder (Dubilier, Igranic, G.E.C., Lissen, Mullard, etc.).

1 2-meg. leak (See above).

1 H.F. choke (Bowyer-Lowe, Burne-Jones, Colvern, Lissen, McMichael, Ormond, R.I. and Varley, etc.).

1 L.F. transformer (Ward & Goldstone in the actual set, but any good make can, of course, be chosen. of fairly low ratio).

1 Ebonite strip, 6 in. × 1 in.; 2 Ebonite strips, 5½ in. × 1 in. } For coils.

1 2-terminal strip, 1 8-terminal strip (complete with terminals). (Belling-Lee, Eelex, Igranic, etc.)

Have a look at the theoretical diagram. You will see that the aerial is taken to a small tapped coil which is coupled to the grid coil. By varying the tappings on the former, various degrees of selectivity can be obtained. As a matter of fact, the set can be made very selective indeed by this arrangement, sufficiently so to get Langenberg through 5 G B.

There are two points about the reaction control that are worth noting, one is that two condensers are employed, a variable for control purposes, and a fixed condenser which is brought in series in order to protect the filament of the valve against the H.T. should the variable accidentally short.

The Switching

The D.P.D.T. switch does two things. When it is over to the left it will be noticed that the anode of the first valve is connected to the anode resistance and taken to H.T. positive 1 in the ordinary way, and that the grid of the second valve is connected to it through a fixed condenser.

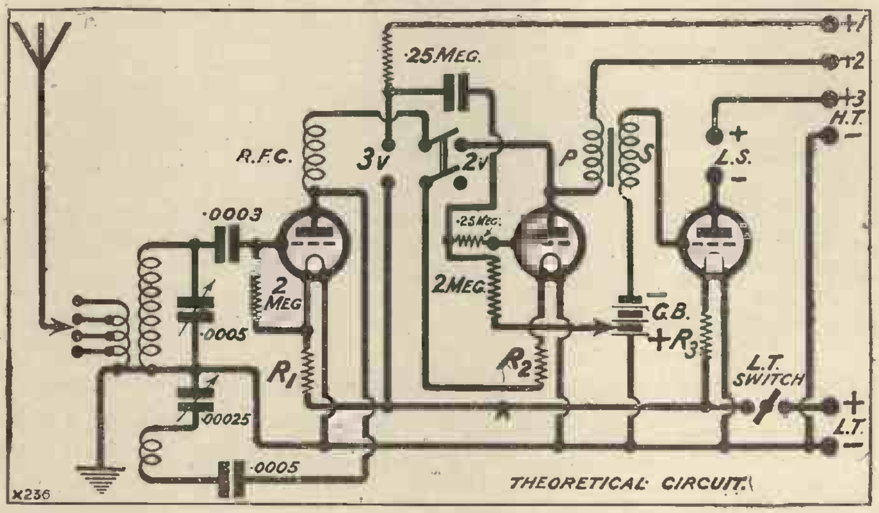
When the switch is taken over to the right two things happen. The filament circuit of the second valve is broken and the anode of the first valve is taken over to the primary winding of the low-frequency transformer. The circuit then becomes detector-low-frequency transformer-coupled. This method of switching is logical, straightforward, and presents no complications in construction.

The "Pure-Power" is a very easy sort of set to build. And it is inexpensive and easy to handle, and is almost ideal as a household receiver. All the leads are taken off from the back, and on the panel are but two tuning controls and two switches. Nothing can be done by inexpert listeners on the front of the panel which will cause any damage. On the left is the aerial tuning condenser, and above the centre switch the reaction control. Now just a few words about the components.

The ·0005-mfd. variable can be of any reliable make. Preferably it should have a vernier control, although this is not essential. The same applies to the ·00025 mfd., although in this case a slow-motion device is not necessary. The low-frequency transformer should be as good as can be purchased. This is a most important component, and it is well worth going to the 25s. types if you can afford to do so.

The R.C.C. Unit

The R.C.C. unit employed in the original set is one due to the Carborundum Company, and it employs resistances made of carborundum. If you use this unit or a Lissen or R.I.-Varley you will need the ·25-meg. resistance which, connected to the grid of the low-frequency valve, acts as a high-frequency stopper. It prevents high-frequency getting through to the low-frequency stages.



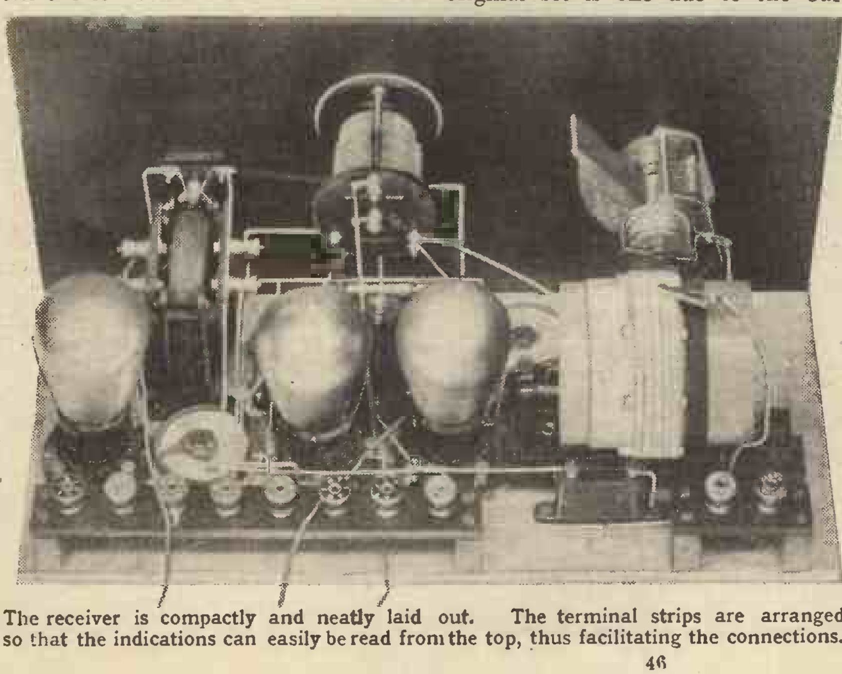
Such resistances are incorporated in Mullard R.C.C. units, and if you use one of these, then you will not need that separate ·25-meg. resistance. The grid of the low-frequency valve is, in this case, taken direct to the Mullard unit, and the rest of the wiring remains just the same.

The high-frequency choke should be a good one, although this does not happen to be a particularly vital component in this set. Of the various other components required, very little need be said. Full particulars appear in the list of components, and various alternative makes are suggested.

First Constructional Step

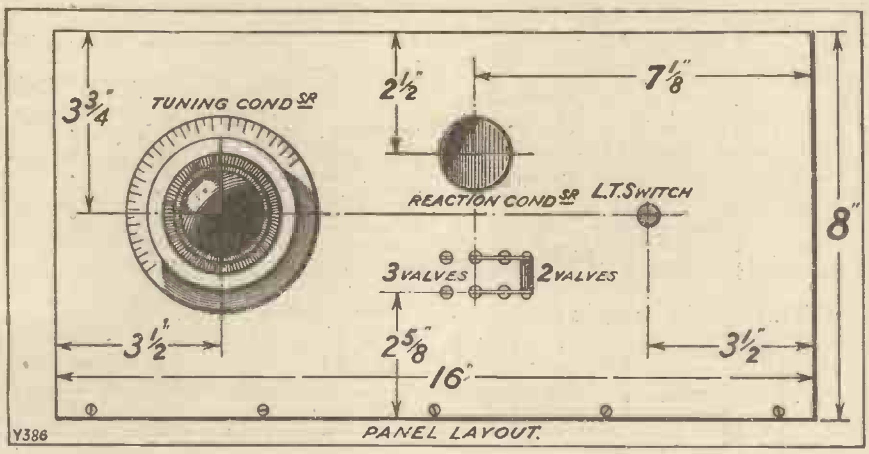
But the values of the various components must be adhered to very closely. You can use alternative makes providing these are of good quality, but you must not deviate from the recommended values if you desire the set to work properly. And this particularly applies to the components inside the R.C.C. unit, and to the grid leaks and condensers.

The first constructional step is to get all the components together, and it is not worth while actually commencing the building of the receiver until you are certain that you have everything you require right down to the smallest screw and piece of wire. I know from experience how annoying it can be to be held up right in the middle of building a new set by the absence of some very small yet very vital piece of material.



The receiver is compactly and neatly laid out. The terminal strips are arranged so that the indications can easily be read from the top, thus facilitating the connections.

You should purchase a panel cut to size. Ebonite can be bought quite cheaply by the square inch at various stores, but it is not easy material to file and square up exactly to fit a cabinet. The panel size is quite a standard one, and panels of the necessary dimensions can be obtained all ready for use.



PANEL LAYOUT.

Having got all the parts together the first task is to drill the panel. A panel-drilling diagram is supplied, and it will be seen that apart from those necessary for the fixing screws, only nine holes are needed. That is, of course, if the variable condensers are of the one-hole fixing variety. Needless to say, the marking out of the holes for the D.P.D.T. switch must be very carefully done, for the slightest slip here will cause irritating misfits between the moving and fixed contacts. Having drilled the panel, it should be screwed to the baseboard. Then the two variables and the two switches should be securely mounted.

The Terminal Strips

You should then carefully lay out the baseboard components so that your arrangement is identical to that shown in the photographs and the wiring diagrams. You will note that the two terminal strips are mounted horizontally instead of vertically. Although this means the sacrifice of a certain amount of baseboard room, the arrangement has several things to recommend it. It gives a neat appearance to the baseboard and the terminal markings can be seen clearly when the lid of the cabinet is open.

The terminal strips are quite standard ones, only they are mounted on small blocks of wood. Full details of these are given in a separate diagram. Any sort of wood can be used for the small mounting blocks, as these do not act as insulators. Preferably, of course, it should be a hard material such as mahogany, oak, or teak.

Having had a preliminary layout of the components, you can mount the terminal strips. First of all, the small wooden blocks are secured to the baseboard by screws passed up from the underside of this latter. The terminal strips having been drilled, these can be screwed down on to the small mounting blocks.

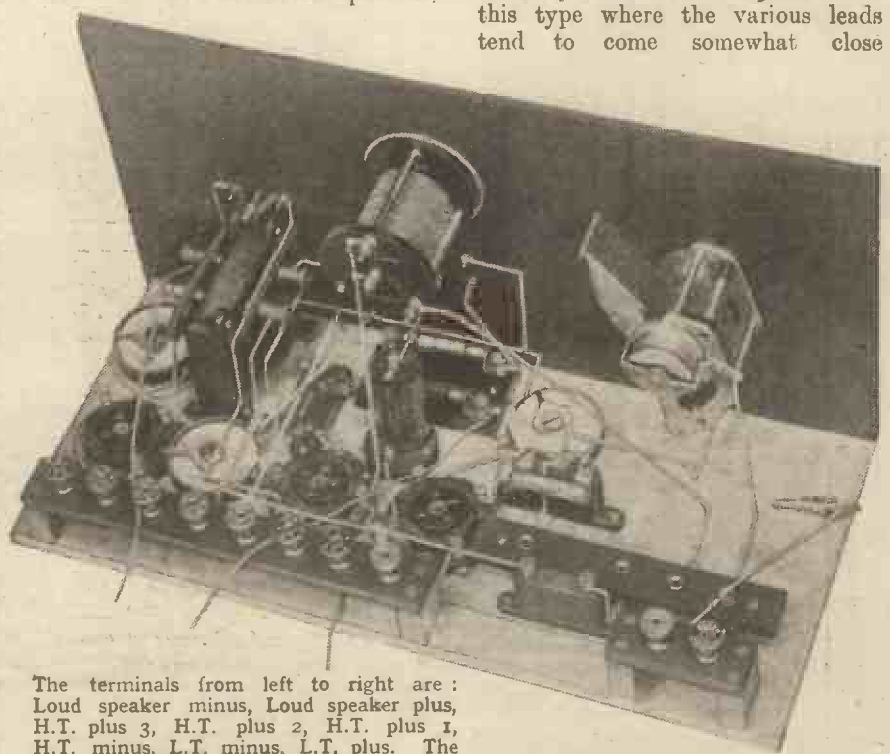
Mounting the Components

Then the remainder of the components can be re-grouped, and the task of screwing them down to the baseboard commenced. As you will discover, there is not too much space available. On the other hand, there is no undue crowding, and there is room available for even the larger makes of the various components, but when the valves and the coils are in position make sure that these will not foul anything. It is advisable to have these accessories in position before anything is screwed down to ensure that this does not happen.

Make sure also that you have the valve holders the right way round. It will be noticed in the wiring diagram and the photographs that these are not all similarly placed in this respect. For convenience in wiring and in order that leads can be kept as short as possible, two of the valve holders have their grid-plate lines out of centre. Note the grid-leak and grid-condenser connections. In the case of the T.C.C. condenser the centre terminal of the three goes only to the condenser itself. A similar scheme is incorporated in the Dubilier type.

Wiring Connections

Most components these days are provided with screw terminals so that soldering will not be an essential operation. Nevertheless, the soldered joint has a permanence which no screw fixing can obtain. And, therefore, I am going to advise you to solder wherever possible in connecting up this receiver. Soldering is not a difficult task, although a bad soldered joint is almost worse than no joint at all. And if you really do feel that you cannot do soldering properly, you would be well advised to avoid it altogether. Glazite is a very useful wire for a receiver of this type where the various leads tend to come somewhat close



The terminals from left to right are: Loud speaker minus, Loud speaker plus, H.T. plus 3, H.T. plus 2, H.T. plus 1, H.T. minus, L.T. minus, L.T. plus. The two terminals on the small terminal strip on the right are the aerial and earth respectively.

WIRING INSTRUCTIONS

(Looking at back of panel with terminal strips nearest you.)

Join a small flexible lead (carrying a tapping clip) to the aerial terminal.

Join earth terminal to right-hand socket of coil holder and moving vanes of ·0005-mfd. variable condenser and H.T.— terminal and L.T.— terminal and one filament terminal of each of three valve holders and to earthing terminal and moving vanes of ·00025-mfd. reaction variable condenser.

Connect L.T.+ terminal to one terminal of L.T. switch.

Join other terminal of L.T. switch to top right point of two-pole double-throw switch and to one terminal of filament resistance (R_3) and to one terminal of filament resistance (R_1).

Join remaining terminal of filament resistance (V_3) to remaining filament terminal of valve holder V_3, and join remaining terminal of filament resistance (R_1) to remaining filament terminal of valve holder (V_1).

Join second terminal from right of coil holder to fixed vanes of ·00025 reaction condenser.

Join third terminal from right of coil holder to one terminal of ·0005-mfd. fixed condenser.

Join other terminal of ·0005-mfd. fixed condenser to plate terminal of V_1 and to bottom of H.F. choke.

Join top of H.F. choke to centre bottom point of double-throw switch.

Join left-hand terminal of coil unit holder to one side of grid condenser and to fixed vanes of ·0005-mfd. variable condenser.

Join grid terminal of V_1 to remaining side of grid condenser and to one side of 2-meg. grid leak.

Connect remaining side of grid leak to a terminal of filament resistance (R_1), as shown in wiring diagram.

Join one side of filament resistance (R_2) to remaining filament terminal of V_2.

Join other terminal of filament resistance (R_2) to top centre point of double-pole switch.

Join bottom left point of this switch to O.P. of L.F. transformer, and thence to plate terminal of V_2 valve holder.

Join bottom right point of double-throw switch to P. terminal of R.C.C. unit.

Join H.T.+ terminal of R.C.C. unit to H.T.+ 1 terminal.

Joint G. of R.C.C. unit to one terminal of ·25-meg. resistance.

Join remaining terminal of ·25-meg. resistance to grid terminal of V_3 valve holder.

Join I.P. of L.F. transformer to H.T.+ 2 terminal.

Join O.S. of L.F. transformer to grid terminal of V_3 valve holder.

Join plate terminal of V_3 valve holder to L.S.— terminal.

Join L.S.+ terminal to H.T.+ 3 terminal.

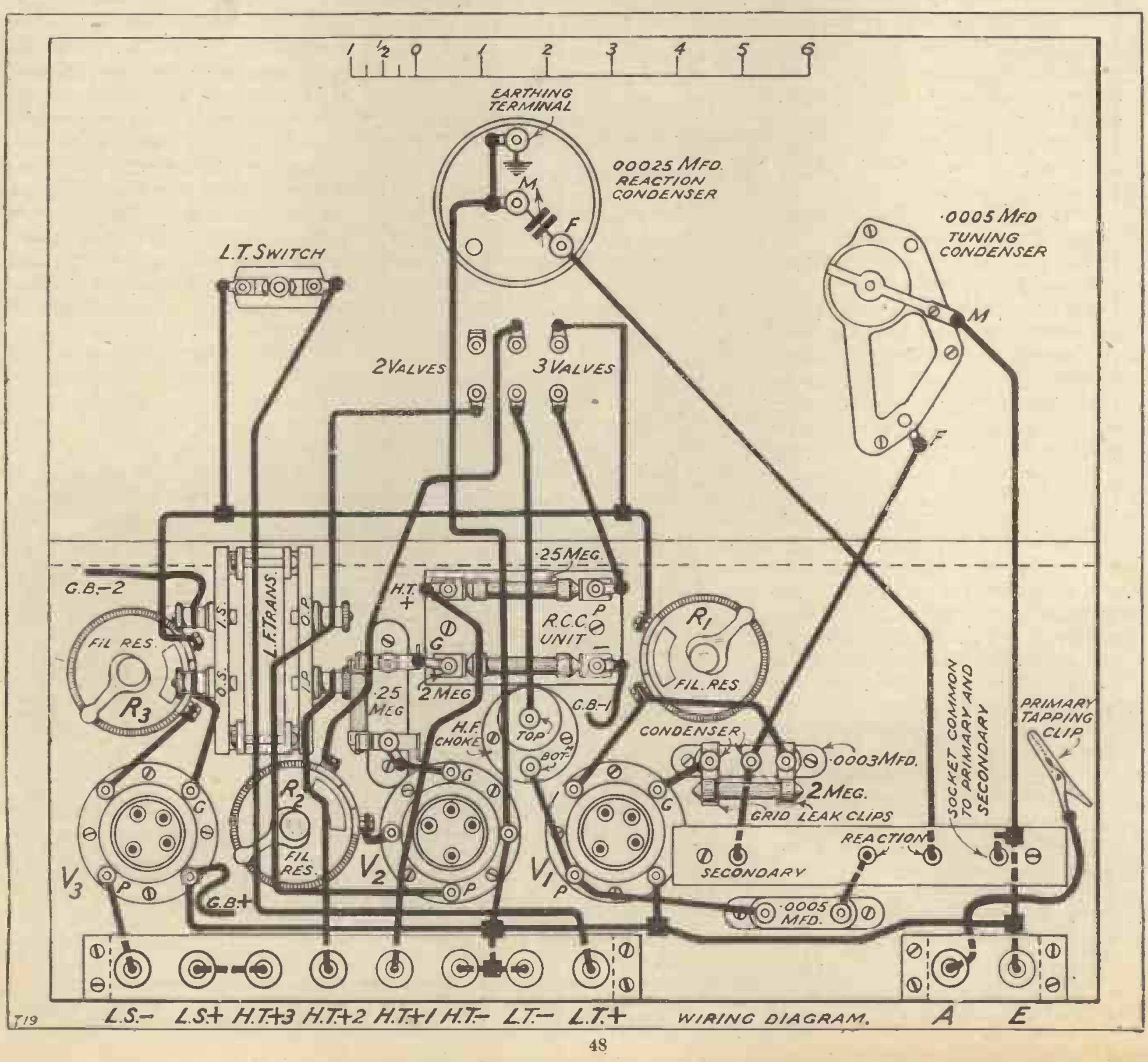
Join short flexible leads having wander plugs to I.S. of L.F. transformer, to "minus" terminal of R.C.C. unit and to some point in direct metallic connection with L.T.—. (Last is taken to filament terminal of V_3. valve holder in original set.) These are G.B.— 2, G.B.— 1, and G.B. + plugs respectively.

One point of double-throw switch has no connection.

This completes the wiring.

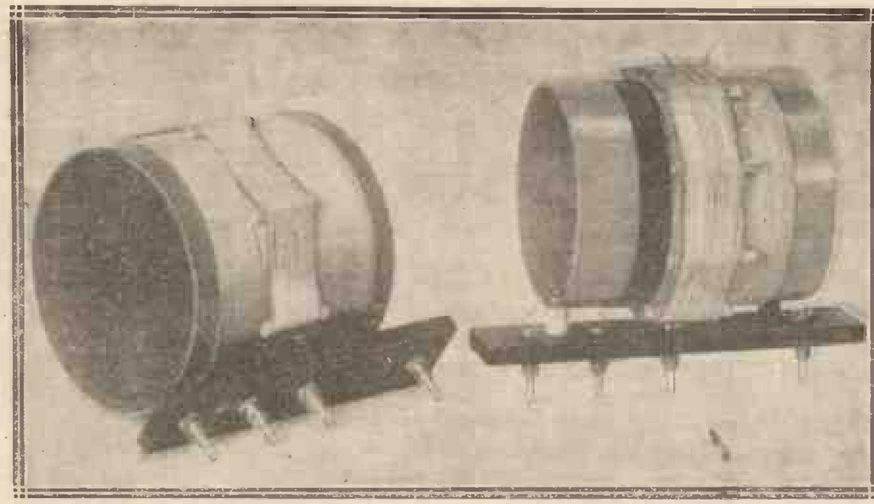
together. You should, of course, keep the leads as short and as widely separated as possible.

Four flexible leads will be required, each about six or seven inches in length. Single lengths of ordinary flexible twin-flex wire, as used for bell wiring and so on, is quite suitable. Two of these leads, those which go to the low-frequency transformer and the R.C.C. unit, as you will see in the wiring diagram, should be provided



WIRING DIAGRAM.

with wander plugs. These form minus connections to the grid-bias battery. The third lead, which goes to L.T. minus should also be provided with a wander plug. This is the grid-bias plus connection. The fourth flexible lead—the one which is connected with the aerial terminal—should be fitted with a small connecting spring clip, as it will have to make connection with one or other of the tappings on the coil unit.



Here are the two coil units needed to cover the high and low wave-lengths. That on the right covers the normal broadcast band.

There is not much more that need be said about the construction of the set, for everything is quite straightforward and free from snags.

You will require two coil units—one for the normal broadcast band and one for 5 X X and the higher wave-lengths. The construction of these coil units is quite a simple business so long as you carefully follow the instructions I am going to give you.

The Coil Units

Each of the coil units embodies three separate windings. Let us first of all take the unit required for the normal range of wave-lengths.

First of all is required a piece of stiff cardboard (well shellacked) or ebonite tubing 3 in. in diameter and 3½ in. in length. About ½ in. from one end a small hole should be pierced in the former, and the first winding should be commenced from this point. This will be the secondary winding, and should consist of 50 turns of No. 24 D.C.C. wire wound neatly in a single layer.

A space of about 1¼ in. will be left on the former, and here, separated from the secondary by only about ⅛ in., should be wound the reaction winding. This should comprise 30 turns of 32-gauge D.S.C. wire, and it should be wound in the same direction. And, by the way, don't forget to leave three or four inches of wire at the end of each winding for connecting purposes after securing the ends through holes neatly pierced in the former.

The aerial coil, which will have to be tapped, must be wound over the secondary coil and separated from this by eight spacers 1¼ in. each in length. These spacers can consist of pieces of the sticks used for stiffening packets of "Glazite" wire or what are known as orange sticks or small circular pieces of soft wood cut by the constructor himself.

Eight Spacers

These eight spacers should be equally spaced round the coil and held in position temporarily with a rubber band. Eventually the winding round them will hold them securely in position.

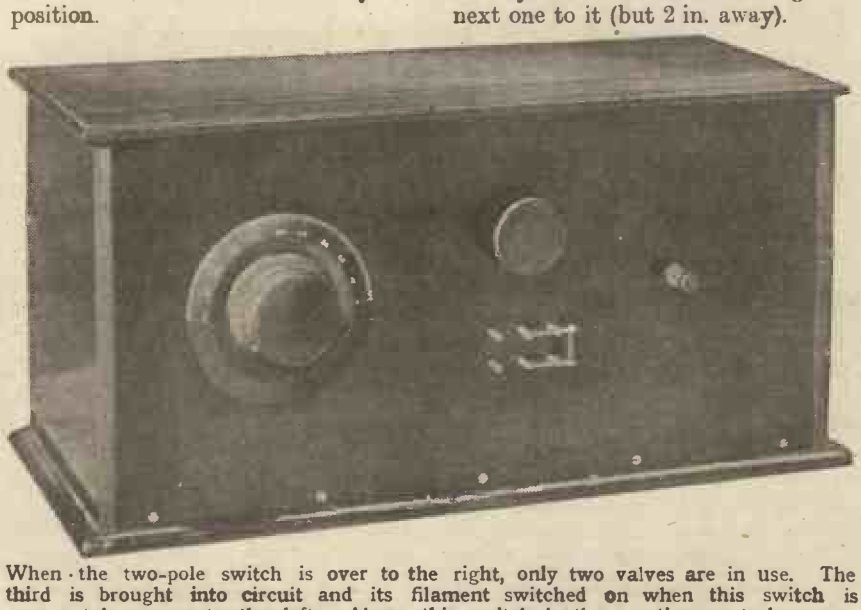
For the aerial coil some more of the 24-gauge D.C.C. wire will be needed. Start the winding by securing the wire round one of the spacer sticks. The aerial winding consists of 25 turns with tapping loops at the tenth, fifteenth, and twentieth turns. These loops should be bared in order that connections can be made to them by means of an ordinary spring clip. The end of this 25-turn winding should be twisted up into a small loop to make the fourth tapping point.

The coil should be screwed to an ebonite strip 5½ in. in length and 1 in. wide. On this ebonite strip should be mounted four "Eelex" or other such plugs. The former can be fixed to this base strip by means of two nuts and screws.

Coil Mounts

The base for the coil unit consists of a strip of ebonite 6 in. by 1 in., upon which should be fixed four "Eelex" or other sockets suitable for the plugs used. The spacing of the sockets must correspond with the spacing of the plugs on the coil unit, one of each being widely separated from its fellows to ensure that the coil is not plugged in the wrong way round. You will see exactly what I mean by this by referring to the photos and wiring diagram. The actual spacing is 1 in. between each of the three sockets and plugs grouped together, the spacing of the remaining one being 2 in.

The connections to the ends of the various windings are as follows: The sockets will be denoted by numbers one, two, three, and four, the fourth socket being that one which stands out by itself—the third being the next one to it (but 2 in. away).



When the two-pole switch is over to the right, only two valves are in use. The third is brought into circuit and its filament switched on when this switch is taken over to the left. Above this switch is the reaction control.

Number one socket should have joined to it the beginnings of both the aerial and secondary windings. The other end of the secondary goes to number four socket (the one widely separated at the one end). The ends of the reaction winding go to socket numbers two and three (the centre ones). The end of the reaction winding nearer the secondary going to socket number two.

Tuning Ranges

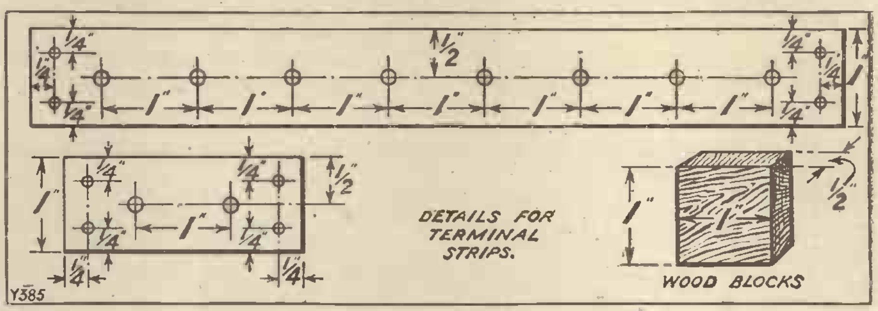
The construction of the coil unit for the higher wave-lengths (5 X X, etc.) is practically the same, except that the former should have a diameter of 3½ in. The windings should be as follows: Secondary, 170 turns of 34-gauge S.S.C. wire; reaction, 60 turns of a similar kind of wire; aerial, 80 turns of the same wire with one tapping at the 60th turn.

The wires used for both coils are, you will note, of three kinds. No. 34 S.S.C., No. 32 S.S.C., and No. 24 D.C.C. You should obtain about ¼ lb. of each, and do not use any other gauges than those specified.

With the smaller unit you will easily cover 200-500 metres, and to increase the maximum it is necessary to increase only the size of the secondary winding, unless you wish to go very much higher (such as for 5 X X, for which the above detailed larger unit is designed).

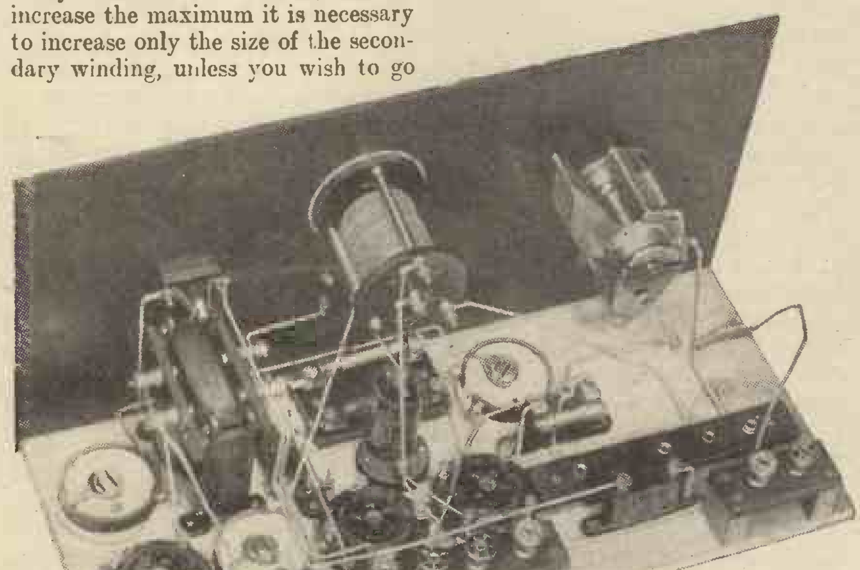
But you will cover most of the popular stations with but the two units.

The grid-bias battery can be mounted on the back of the cabinet just above the large terminal strip. Messrs. Siemen's supply grid-bias batteries having "hinges" embodied in them, which enable them to be mounted in the position indicated by means of drawing pins. Failing this particular kind of battery, grid-bias battery clips will be needed, and these can be cut from aluminium, brass, or other such metal, and screwed inside the receiver cabinet.



The Valves to Use

If you are going to use a power valve, you will require a grid-bias battery of 15 volts. The H.T. battery should be of at least 100 volts. With any set using more than two valves, it is advisable to purchase one of the high-capacity types of battery.



Another back-of-panel view of the "Pure-Power" Three. On the right will be seen the aerial flexible lead to which is attached a tapping clip. The other flexible leads go to the grid-bias battery.

The valve used in the detector position should preferably be of the high-frequency type, but not of the very "high mu" variety. One having an impedance of about 15,000 ohms will be quite O.K., such as, for instance, the D.E.L.610, P.M.5.X., S.S.660, and so on. In the second stage you will need a low-frequency valve of rather low impedance. If you can afford the drain in H.T. which will result, I would advise you to use here a small power valve. In the last position a power valve is essential, and, better still, a super-power valve, although if this is used you will need an accumulator H.T. supply or a mains unit, and much more grid bias than previously indicated.

Before actually connecting up the batteries, check over the wiring in order to ensure that everything is in order.

When you are sure that you have everything absolutely correct, you can proceed with the first "try out." Put the maximum H.T. on the last valve, that is H.T.+3, about ninety on the second and anything between sixty and ninety on the first. Between 4½ and 9 volts grid bias will be needed on the second valve, and probably the maximum available on the last valve. You will find on the carton of the valve, or on an enclosed leaflet, more definite information regarding the grid-bias battery value, as this will vary with varying types. Of course, slight readjustments will be necessary when the set is in operation in order to get best results.

Should Have no Trouble

I do not think I need say any more about the handling of this receiver, for I do not think you will have the slightest trouble in getting it to work properly. And I am sure everyone who makes it will be completely satisfied, and will agree with one of my recent correspondents who wrote, "A good Det.-2 L.F. wants some beating." It certainly does!

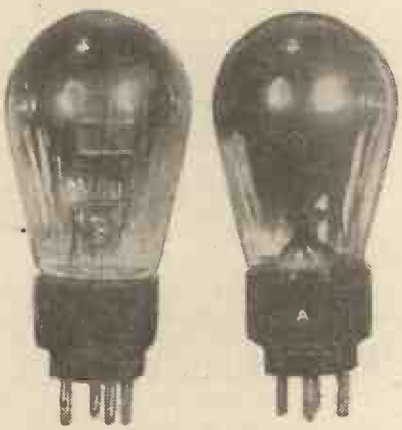
By the way, the detector valve precedes both a resistance- and a transformer-coupled stage when the switching is used, but as low-value R.C. is employed there should be no need to readjust the H.T. I have indicated a compromise which is perfectly satisfactory in practice from all points of view. Providing you adhere to the various recommendations you will have no cause to complain of the results the set gives.

NEW VALVES FOR THE MONTH

A brief description and test report of some of the new valves received during the last month.

By KEITH D. ROGERS.

I HAVE just had another field day testing a series of new valves sent in to me by various manufacturers during the last month, and a very varied and interesting lot of valves they were too. Some of them are not yet on the market, and some, I believe, will not be going on the market, but although many were good, many were moderate and some were really bad—these latter, I hear, have been withdrawn before they reached the public—I am glad to see a new series which were consistently good.



The B.T.-H., B.215P. and the B.210L., discussed in the accompanying article.

These are those just placed upon the market by the B.T.H. Company, and consist of the B.210H., the B.210L., and the B.215P.

Efficient Two-Volters

I have given them a thorough test, and find that the whole three of them are very satisfactory. They employ a nickel filament which, it is claimed, enables a longer filament to be used, resulting in greater emission, a low internal resistance, and a specially long life. The filament certainly is very long, but whether the life will be any longer, I cannot yet say, as I have only had the valves in my possession a few days.

Before going any farther, there is one criticism I should like to make about this series of valves, and that concerns the B.210H. As a valve, it is quite a good little fellow, but why the makers have designated it as an "H" valve I really cannot see, because the valve is not really suitable for high-frequency amplification, unless resistance or tuned-anode coupling is employed—two forms of coupling which are not often used nowadays, especially with the ordinary type of valve.

For R.C. Coupling

We know tuned-anode is used with the screened-grid type of valve, but with other types its flatness of tuning has rendered it practically obsolete. Resistance-coupling, of course, in practically every case is quite useless for H.F. amplification.

Now the B.210H. is really suitable, and is designed, as stated by the makers, for resistance-coupling, so that it is a pity that they have given it the letter H. As regards its performance, I can say the valve is quite a good one. Its filament voltage is rated at 2, it takes ·1 amp., and its amplification factor is 35, with an impedance of 87,500 ohms. This gives it a mutual conductance of ·4; not a very high figure, but one which is sufficiently high for fairly good amplification.

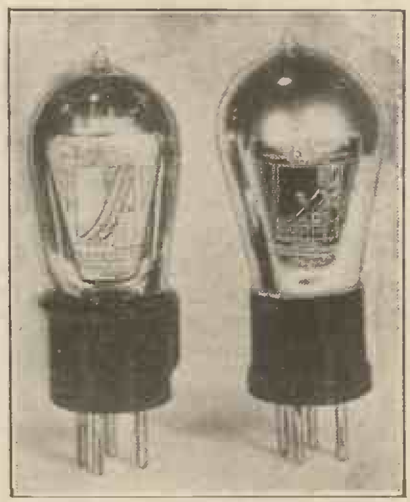
The B.210L. is a good valve, and this has a much higher mutual conductance, having a figure of ·9. Its A.C. resistance is 14,000 ohms, and the amplification factor is 13. This is a good all-round detector, H.F. or first-stage L.F. valve, and I have found it to work excellently in either of these positions. As a second-stage resistance-capacity valve it is not bad either, though, of course, it is not designed for this purpose.

Useful L.F. Amplifier

The third valve in this series is the B.215P., which is a useful little power valve, having an impedance of 7,000 ohms with an amplification factor of 7. It has quite a useful characteristic curve, but it will not stand any very great grid voltage variation, and this can hardly be expected. But for a second-stage L.F., which is not expected to carry too much power, it can be confidently recommended. As a matter of fact, I regularly use one of these valves in a short-wave receiver with great success. I have chosen it from a whole series of 2-volt valves because it seems to give a somewhat quieter background than a great number of them—an essential feature when short-waves are being received.

First of New Range

Another interesting valve I have just tested is the Radion 4-volt H.F. designed by Prof. A. M. Low. This valve is rated at 3·75 filament volts, and takes roughly ·1 amp. at this voltage. On test it gave quite



Two useful valves—the Radion Super-power and the Super L.F. valves, which will be reported upon at a later date.

useful results as an H.F. or as a first-stage L.F. valve, while as a grid-leak detector it was fairly good. It is a useful little valve, and the makers can be congratulated on one very neat little idea they have incorporated, the affixing to the bulb of the valve itself the characteristic curve of that particular type of valve. This is a very useful point and should be of great assistance to the average man who does not like to have a whole lot of papers of valve details lying about. With the Low valve, however, one has grid bias and all necessary figures always in front of one as long as the valve is in being.

Useful Impedance

There is, however, one point I would like to draw the manufacturer's attention to, and that is the wording on their box which describes the uses of the valve. They state that, "this valve has been specially designed for the H.F. stages of amplifiers employing tuned-anode or H.F. transformer-coupled stages." This, to me, seems somewhat contradictory, since it is not usual to try a fairly high-impedance valve such as would be really suitable for tuned-anode coupling in a transformer-coupled stage. The impedance of this valve, by the way, is given as 28,000 ohms, and it has an amplification factor of 13.

Resistance Values

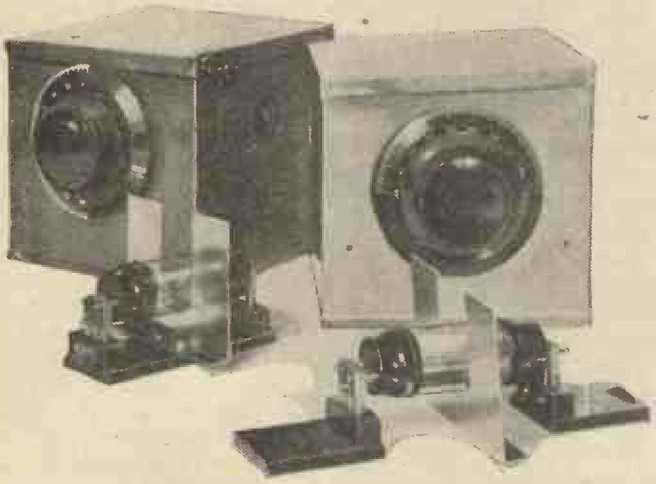
Then they go on to state that it is also "eminently suitable for resistance-capacity-coupled stages where the resistance included in the anode circuit is of the order of 20,000 to 200,000 ohms." This appears to me to be a somewhat wide margin, and on test I have found that the valve will give fairly good results on resistances of 50,000 upwards with a marked falling-off of amplification below 50,000 ohms. As a matter of fact, I should not like to use the valve for resistance-capacity-coupling with anode resistances under about 100,000 ohms if I wanted to get the best out of it.

A Good Valve

It is a pity to recommend, or rather to condone, as it were, the use of an anode resistance of lower value than the actual A.C. resistance of the valve itself, for it is well known that in order to obtain any reasonable amount of amplification from resistance-coupling, one has to have a resistance of at least twice, or three times, that of the valve itself. As a rule this resistance is of the order of four times, so that with a valve of 28,000 ohms impedance, the figure given for this valve, we should need an anode resistance certainly of quite 100,000 ohms.

Finally, the box goes on to say that the valve will be found to "work admirably in all stages of receivers using 4-volt accumulators." This is a wide statement, because it is obvious that the valve cannot work satisfactorily in *all* stages of receivers. For instance, as the last valve in a set employing six, the valve would be badly overloaded. It could not be expected to carry the grid swing required, and horrible distortion would result. The valve can almost be described as a general-purpose valve, although its impedance is high, but I cannot agree that it is really suitable for resistance-capacity-stages, except perhaps for second-stage operation. The valve is quite a useful little valve, but it must not be expected efficiently to carry out all the various duties assigned to it by its box description.

It would not be fair on any valve, because one cannot alter the physical constants of a given valve, and therefore it is impossible to construct a valve suitable for tuned-anode, or transformer-coupled H.F., resistance-coupled L.F., and then to wind up by saying that it will work admirably in all stages of receivers using accumulators of the voltage of that valve. I think the claims on that box are a little wide, and would lead the average user to expect too much. It is quite a good valve, and it is a shame to spoil its chances by claiming more than it can efficiently perform.



The use of completely screened stages and the screened-grid valve enables very efficient H.F. amplification to be obtained. The photograph shows two screening boxes and valves and valve holders adapted to fit the boxes, which can now be obtained ready for use.

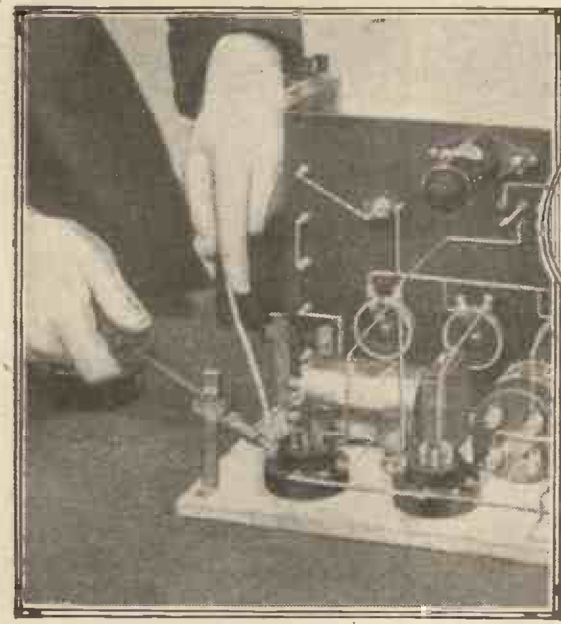
REACTION ON THE SHORT WAVES

You are no doubt able to pick out the right size of reaction coil to use with any given grid coil on the broadcast band. When you get down on the short waves the selection is not so simple. With twelve turns in the grid circuit and eight in the anode circuit, for example, you will normally find that you can persuade the set to oscillate over the tuning range provided by a ·0003 variable condenser. Now, if you change the grid coil and put in one of six turns, you might expect to be able to go a good deal lower down the wave-length scale with the original reaction coil of eight turns.

Wave-length Changes

You will certainly be able to tune a few metres lower, but not nearly so much as you might suppose. If you can get the set to oscillate with the variable condenser at its minimum setting and with the reaction two or three inches from the grid coil, well and good. But when you bring the reaction coil nearer, you will find that the wave-length will go up. The trouble is that on these short waves the size of the anode coil controls your wave-length far more than it does on the longer waves.

The following is a pretty good guide to the right size of reaction coil to use: the number of turns on it should be such that if it is put half-an-inch away from the grid coil, the set oscillates most strongly at the *midway* setting of the tuning condenser, the reaction condenser being "all in." Be careful that the reaction coil is connected the right way round, as when the anode and grid coils are close together the set will sometimes oscillate through the capacity coupling between the two coils. A.V.D.H.



Wiring a Receiver

A really practical article dealing with the little soldering difficulties that crop up when constructing a wireless set.

By A. V. D. HORT.

In order to illustrate clearly the important points to be observed in dealing with a receiver, let us assume that we are about to wire an actual receiver. The accompanying photographs show the appearances of the backs of the panels of various sets, and other vital points where soldering has to be carried out.

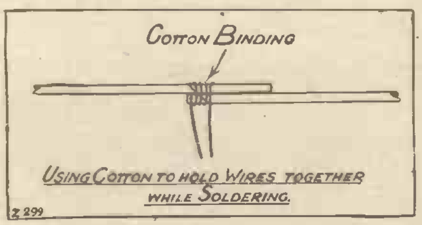
The first operation is to tin all the terminals and soldering tags to which connections are to be made; these are indicated in one photograph by arrows. Rub the ends of the terminal shanks with emery cloth or file them until they are bright and smooth all over.

Preliminary Operations

They may *look* clean as they are when purchased, but in fact they are not clean enough for soldering. At any rate they have a thin film of oxide on them, or they may have been lacquered. Clean all the terminals before tinning any of them, as then several of them can be tinned without replacing the iron in the fire, only a few seconds being required for each terminal.

To tin a soldering-tag the iron is kept in the flame.

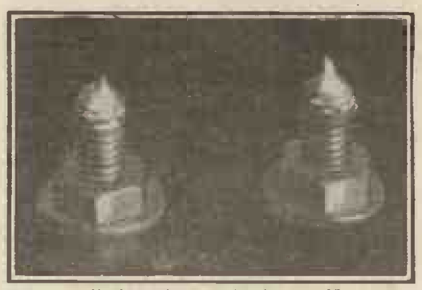
When you have cleaned the terminals, clean out the metal dust which has been removed, and prop the panel up on a few blocks of wood so that the controls on its face are well clear of the bench. Make sure that it is quite steady to work on, since it is extremely awkward to solder when the panel moves at a touch of the iron. If you are using paste flux, or any kind which sputters when the hot iron touches it, press pieces of soft blotting paper down over the terminal shanks. This will save a lot of trouble in cleaning the panel afterwards, as the paper will act as a protective covering which can be torn away after.



Avoid Too Much Flux

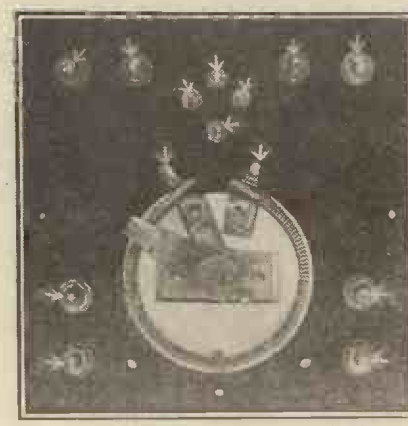
Now put just a trace of flux on the end of each terminal shank. If you are using resin, moisten the ends of the terminals with a little water from a brush or rag and sprinkle a very small quantity of the powdered resin on this. The water will help the flux to stay where it is wanted, and any surplus powder can be brushed off the panel later on.

Next, turn to the soldering iron. If it is hot enough, press the stick of solder on to one tinned face until there is a small pool of molten solder on it. Do not make too large a pool.



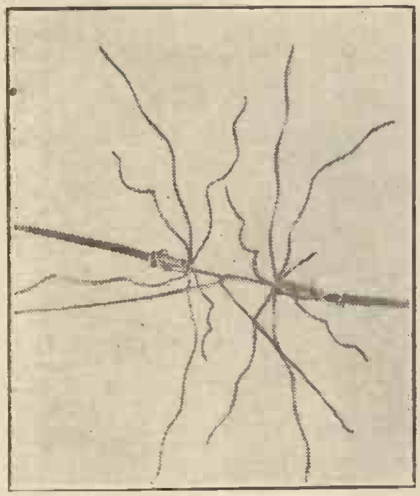
Two well-tinned terminals. Note the "spike" of solder, due to lifting the hot iron properly.

Experience will teach you just how much should be run on for a particular job. At first it is a good plan after applying the stick of solder to tilt the iron point downwards over a tin for a moment, without shaking it at all. Any surplus solder will then run off into the tin, instead of falling into the receiver and injuring the panel or the components.



In this L.F. amplifier the points indicated by arrows are those to be tinned.

When the iron is quite ready, bring the face with the extra solder on it into firm contact with the end of a terminal and keep it there for a few seconds. With only a trace of flux on the terminal, about two seconds after the fizzling and smoke of the burning flux has ceased will be the correct moment to remove the iron. Lift the iron off straight upwards, as then a good blob of solder will be left on the terminal, facilitating the subsequent attachment of a connecting wire.



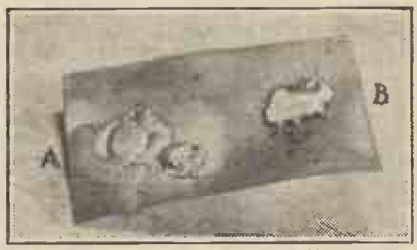
Joining aerial wires. The strands are "fanned" out, and the two central ones are hooked together.

Test Each Terminal

If the solder has taken properly, it should be impossible without considerable violence to break off the blob from the terminal when once it has cooled. Test each blob by pressing it hard sideways when it is cool. Very often, during the first few attempts at soldering, it *will* break off, which means that the solder has not taken really properly. In this case, clean the terminal again with emery cloth, put on a trace of flux and apply the solder with the iron as before. Never try to tin a terminal which has "failed" in this way without cleaning it and starting from the beginning again.

Avoid Prolonged Heating

One thing to avoid when a terminal stubbornly resists being tinned is keeping the iron resting on it for a long time, in the hope that the solder will eventually take. If the iron is properly tinned and if the terminal is clean, the heat will be transferred from the one to the other very rapidly. Prolonged heating of the terminal will allow too much heat to travel up its shank, with the result that the ebonite panel will be softened where it passes through. If, further, the head of the terminal above the panel becomes too hot, the surface of the panel round its rim will be burned, with consequent detriment to the appearance of the finished receiver.



The solder at A has "taken" properly on the copper foil, and has flowed easily at the edges. But at B, it has not, and is gathered into a blob.

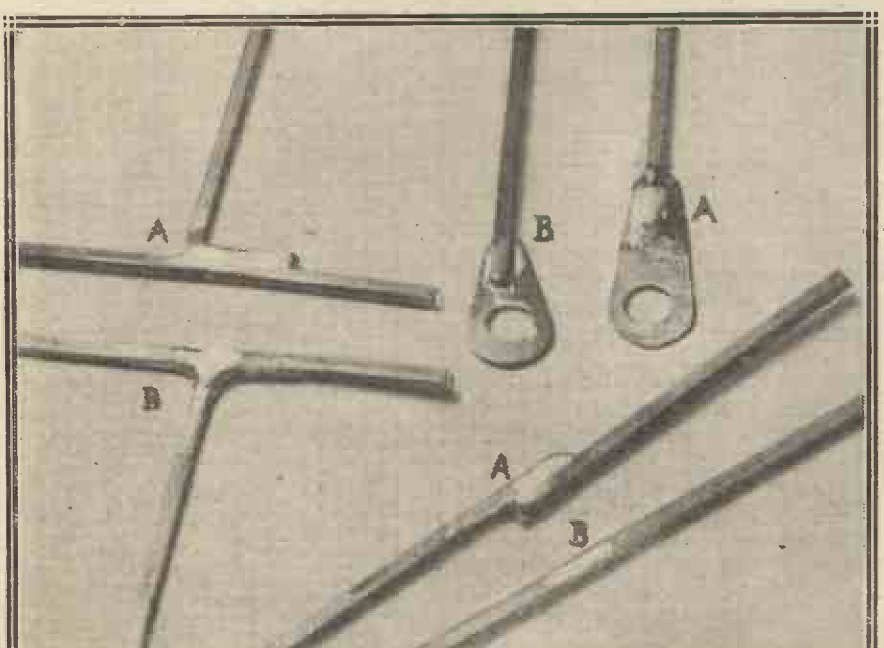
The soldering iron must touch both the terminal and the wire.

Large terminals will, of course, require a more prolonged application of the iron to raise them to the necessary temperature than small ones. The beginner is recommended to try a few experiments with various terminals in an odd scrap of ebonite before attempting to work on an actual receiver.

Tinning Soldering Tags

With an iron of medium size you will find it quite possible after a little practice to tin several terminals before replacing the iron in the fire. It is, however, useless to attempt to work with an iron which is not hot enough, as the solder will then refuse to take on the work. A sure indication of too cold an iron is that "stickiness" or "tacky" state of the solder on the bit which has been mentioned already. The solder should be perfectly fluid on the bit.

After tinning the terminals, turn next to the soldering tags. Those which are placed on bolts which pass through ebonite and which are removable should preferably be taken off for tinning, as this considerably simplifies the operation. It is true that tags are usually tinned already, but more often than not you will find it much easier to solder wires to them if they have a fairly substantial



Good and bad joints—in each case A is to be preferred to B. (The tag marked A has a mound of solder which covers the end of the wire.)

coating of solder put on them beforehand, the ordinary tinning providing only a very thin layer.

The tinning of a loose tag is very simple. Hold it in a pair of pliers by the end which is drilled for fitting on to the bolt and put a trace of flux on one side of the other end. You will not usually find it necessary to clean tags with emery cloth, unless they are not tinned at all already. Apply the stick of solder to the top face of the iron without taking it out of the flame (unless, of course, it is in a fire), and press the flux-smeared side of the tag on this face of the bit for a few moments.

Even Coating Essential

The appearance of the edges of this coating of solder will be a sound guide as to whether the solder has taken properly or not. If it has not taken there will appear to be a fine line of division between the edges of the solder and the surface of the tag, the solder tending to be drawn up under itself, so to speak. If it has taken,

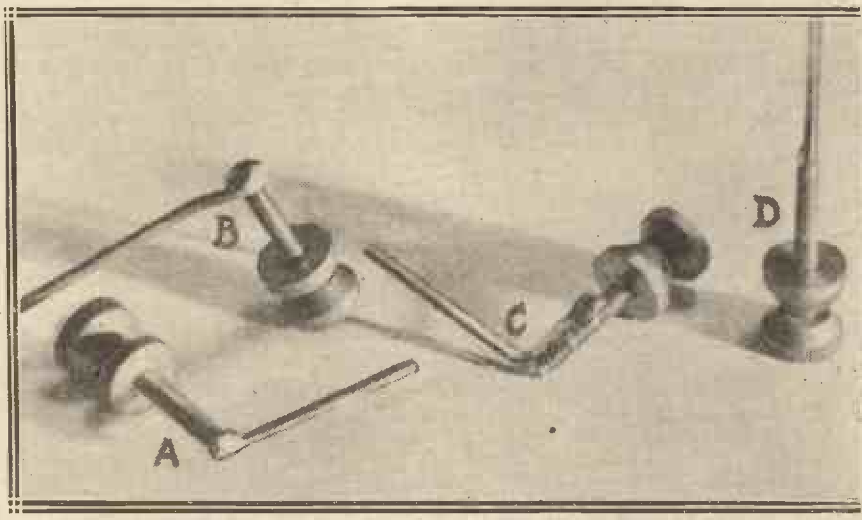
The three stages in the soldering of a flex lead—insulation removed, strands twisted, soldered and wrapped, and finally the spade tag fixed.

no such line will be visible, but the edges of the solder will have spread smoothly, as though integral with the surface of the tag. A comparison with water may be helpful as a further indication of the correct state of affairs. The solder should appear as water does when lying on an already wet surface, and not as it does on an oily or dry polished surface; in a smooth pool, and not in a sharply defined lump or blob.

Preparing the Wires

If there are any tags which you cannot remove from the receiver, you will have to tin them by the method described above for terminals, applying the iron to each tag in turn The same precautions should be observed to avoid the burning of ebonite parts, and the hot iron must not, of course, be allowed to come into contact with any ebonite.

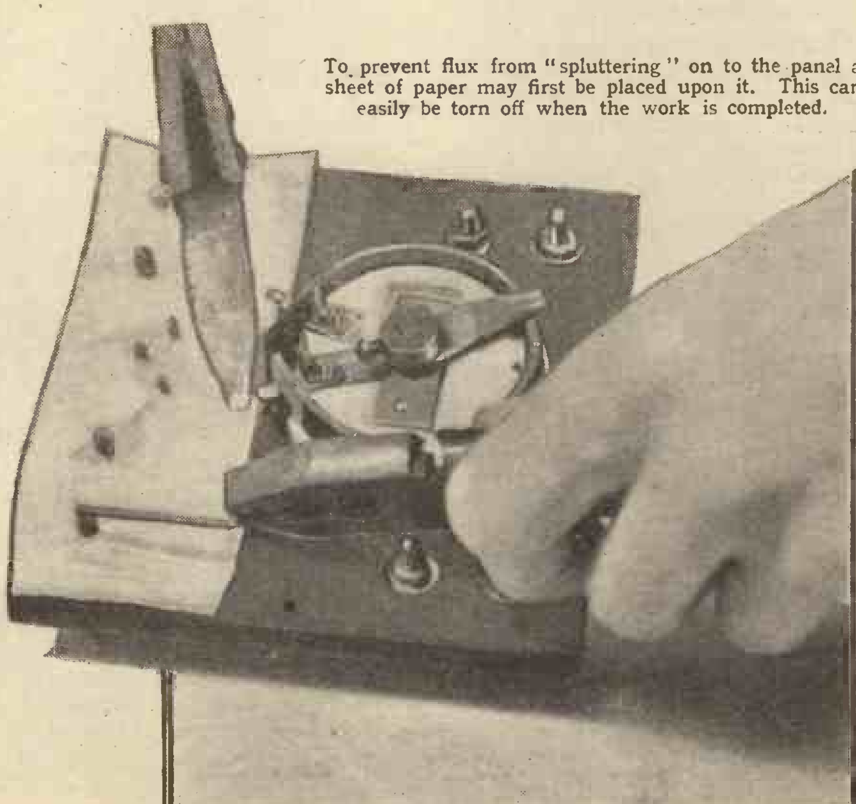
The final operation before proceeding to wire the receiver is to tin the ends of the wires themselves. This again may appear superfluous with wire already tinned, but the same argument applies here as in the case



Good and bad joints. A, sound and simple to make ; B, strong and neat ; C, strong but spoils the thread ; D, weak and not recommended.

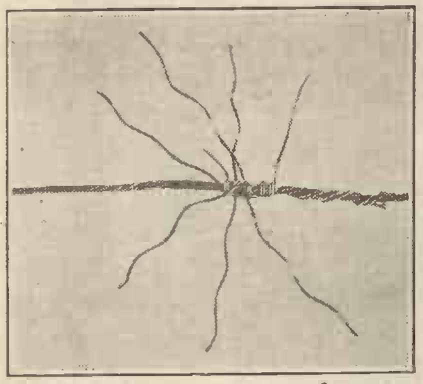
of the tags. First bend the stiff wires to their final shape and cut them to exact length. Then tin the last $\frac{1}{4}$ inch or so of both ends of every length of wire. To do this rest the end of the wire in the pool of solder on the bit as it rests in the flame, and turn it round and round, applying a little flux at the same time, and rubbing the wire gently on the bit to ensure an even and intimate covering of solder.

Flexible wires, such as those used for the connections to the moving-coil block of a coil holder, require more careful treatment. The flex most commonly used has a binding of cotton over the stranded wires and a rubber tube over this. First strip about $\frac{1}{2}$ inch to $\frac{3}{4}$ inch of the insulation from the ends of the length of flex. The rubber tube can be nipped between the nails of the finger and thumb and pulled off. If it is too



To prevent flux from "spluttering" on to the panel a sheet of paper may first be placed upon it. This can easily be torn off when the work is completed.

thick for this, nick it round with a sharp penknife, taking great care not to cut right through into the wire. Then slip off the loose piece, twisting it slightly to free it, unwind the cotton and break it off short. When the flex



A further stage in an aerial-wire joint. The separate strands are bound round and round to make the connection secure.

is to be soldered, this way of removing the insulation is recommended in preference to the alternative method of burning it off, since the burning insulation would deposit soot on the strands of the wire and make them more difficult to clean.

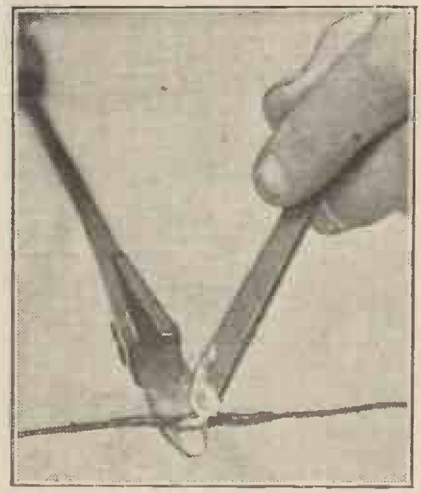
Dealing With Flex

If the strands of the flex are tinned already, twist them tightly together and solder them by resting the ends in the pool of solder on the iron for a few moments, with the addition of a little flux. The end of the insulation must not be allowed to touch the hot iron, and the rubber should not be handled until the wire is quite cool, as it will be softened by the heat.

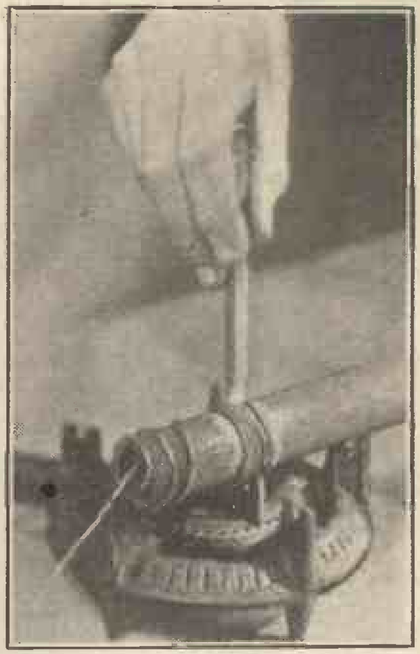
The strands of untinned flex should be untwisted, spread out into a fan and cleaned with fine emery cloth. Hold the cloth between the finger and thumb and draw it gently over the strands from the standing insulation towards their free ends. Then twist them together and solder them as above. To make a well-finished job, bind a small piece of rubber or adhesive tape over the end of the standing insulation. This will effectively exclude moisture and prevent the insulation from fraying.

Wiring Up

When all the terminals, tags, and wires have been tinned, the wiring of the receiver can be commenced. Provided that the tinning has been thoroughly carried out, it will suffice in making each joint to hold the appropriate wire and terminal in contact and to touch them with the hot iron for a moment, when the joint will be complete. In order to



To complete the aerial joint, solder is run into the centre as shown.



Soldering the connection to an earth pipe.

make quite sure that the joints are firm and rigid, it is best to add a little solder to each joint from the iron.

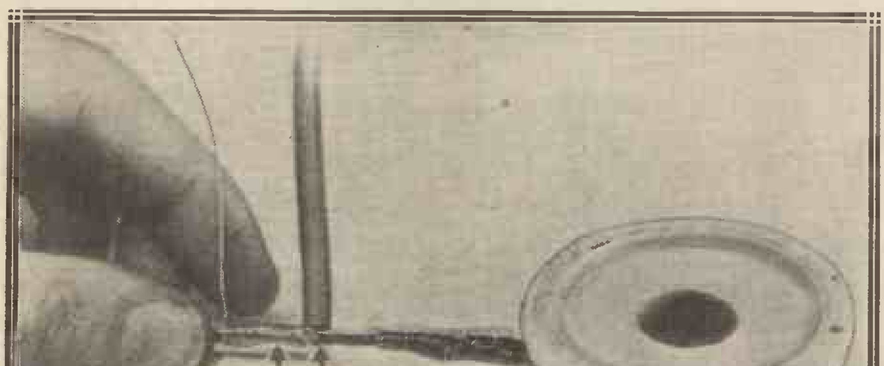
To solder wire to a terminal proceed as follows. Run a small pool of solder on to one face of the bit and hold the wire with a pair of pliers in the correct position. Then press the tip of the bit on one end of the wire and the terminal shank, so that the face carrying the extra solder makes contact with both wire and terminal. The tinning on both will melt at once. Move the iron about very slightly as it rests on the joint, and some of the solder will run down from the bit into the joint, fusing with the solder already there. As soon as this occurs take the iron away, keeping the wire steady until the solder has set.

The "Strength" Test

With the smaller joints, the solder will set almost at once as soon as the iron is removed. With larger joints you will have to wait for a few seconds, but it is easy to see when the solder sets by watching it closely. In the molten state on a freshly made joint the surface of the solder is quite smooth and glossy. When it sets it contracts slightly, the surface sometimes acquiring fine visible wrinkles in the process. This contracting movement of the solder is easily discernible in even a small blob.

As each joint is made, give a good pull to the wire, to ensure that the solder has taken properly and is not just lightly adhering to one or other of the parts.

(*Continued on page* 100.)



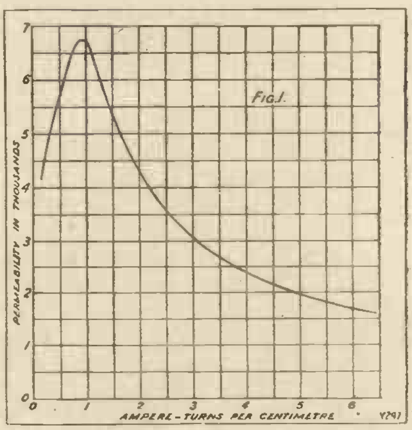
Joining the lead-in to the aerial wire. Solder is run into the joint between the two arrows.

The INDUCTANCE of L.F. CHOKES

"A choke which is truthfully stated to be 50 henries is also as truthfully 5 henries." An article upon a subject which is too often neglected.

By MARCUS G. SCROGGIE, B.Sc.

THE use of iron-core chokes in broadcast receiving apparatus is now very extensive, as they are essential in the construction of battery eliminators, choke output circuits, and other applications. It is hardly too much to say, however, that they are the most generally misunderstood components in common use. When one buys a rheostat, the maker is prepared to state its electrical value in ohms, and it is a simple matter to verify the correctness of his figure.



Similarly, a condenser, fixed or variable, is stamped with its capacity. In many cases, also, tuning coils are sold with the amount of their inductance in microhenries marked on them. But when it comes to the purchase of a choke coil it is not quite such a simple matter to know what one is getting.

"It All Depends . . ."

Sometimes the inductance is stated, and sometimes it is not, but it does not much matter which. One might as well specify the size of a toy balloon, regardless of its dependence on the amount of air blown into it. A choke which is truthfully stated to be 50 henries is also quite as truthfully 5 henries. It all depends on how much current is passed through the winding.

What, then, do we understand by the inductance of an iron-cored coil? If an electric motor be examined, it will be found that not only is the horse-power quoted, but also quite a lot of other information such as the voltage, frequency and number of phases if alternating, temperature rating (continuous or intermittent), and so on. A 20 horse-power motor rated at 240 volts could be made to give perhaps 200 horse-power at some other voltage, but it would not last very long. Similarly, a component used in a wireless set cannot be completely specified by a single figure, but should be issued with details of the conditions for which it has been designed.

The Iron Core

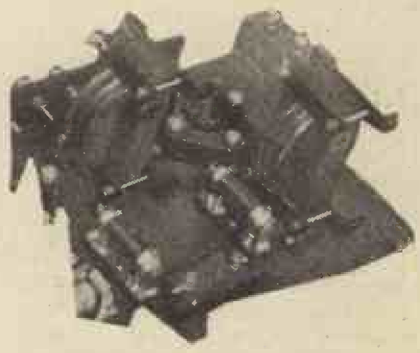
This is almost invariably done in the case of valves, but it is still not generally realised how meaningless it is to talk about a choke of so many henries without also at least furnishing particulars of its rated current. Even then it is only a rough guide.

To appreciate this properly one has to consider the action of the iron core, which is one of the most complicated properties of materials, and is still imperfectly understood. But leaving out the finer aspects of the matter, we can get a useful idea by thinking of the core as a sort of multiplier or concentrator of the magnetism set up by the current in the coil.

That is to say, if the coil alone traversed by a certain current gives rise to a given strength of magnetic field, and the addition of a complete iron core causes the field to be 500 times as strong with the same current, then we say the iron has a permeability or multiplying power of 500. But here comes the snag; if we measure the permeability with double the current, it will almost certainly not be the same as before; it may be more or less, according to the circumstances. If we measure the permeability for a large number of different strengths of current, a curve can be drawn showing how the permeability varies with current.

Sad to relate, our curve would only hold for that one particular coil. This disadvantage can easily be overcome by drawing the curve not on a basis of amperes through the coil, but ampere-turns per unit length of core. It is immaterial whether we pass one milliampere through 10,000 turns or 10 amperes through 1 turn—provided it does not burn out.

The product of amperes and turns is divided by the length of the core, and the result is the magnetising force. The advantage of working on this basis is that a certain magnetising force with a particular sample of iron is associated with the same permeability, no matter what coil is used. Fig. 1 shows how the permeability of a particularly good sample of iron varies.



Two L.F. chokes of well-known and reliable make.

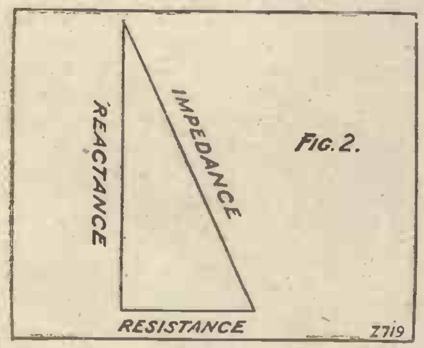
It is important in measuring permeability thus to observe that the coil must be completely closed, without even a thousandth of an inch gap, because the permeability of iron may be as much as several thousand, so that the interposition of even a small film of air would very greatly cut down the permeability as a whole.

It is not unlike an ordinary electrical circuit, where the best conducting copper may be used for 99·9 per cent of the distance, but if the remaining portion consists of air, not much current can get through. There is never quite such a marked contrast as this between the permeabilities of iron and air, which is fortunate, as it is extremely difficult to get a really good magnetic joint.

Lines of Force

The strength of the magnetic path or field has been spoken of rather vaguely so far, and it will be as well to explain at this stage that it is measured (theoretically at least) by noting the force with which a single pole of a very small permanent magnet is attracted or repelled. Now a magnet with a single pole just does not exist, as opposite poles always go in pairs and can never be separated, but physicists have found how to determine the effect that *would* be produced if they could get a single pole of a magnet.

They also have a reason for choosing a particular strength of a magnet to act on, which it is unnecessary to go into here. As it is not known for certain what a magnetic field consists of, it is imagined to be made up of invisible closed loops or lines of force, the number of which passing through



unit area is indicated by the degree of force experienced by the single magnetic pole in that locality.

Thus, one speaks of so many lines per square inch or per square centimetre, this quantity being usually referred to as the flux-density. The total flux or magnetic field set up by the coil is given by multiplying the average flux-density by the cross-sectional area of the core. It is important to notice that if the flux-density is in lines per square centimetre, then the magnetising force must be in ampere-turns per centimeter and not per inch or yard, for we must not mix units in the same calculation.

Permeability of Iron

It is known that every amp. turn per cm. yields 1·26 lines per sq. cm. in air. The flux-density in iron can be calculated by multiplying the density in air by the permeability of that sample of iron for that particular magnetising force. It is because the permeability varies so much with the sort of iron and the magnetising force that the inductance of the coil varies, for the inductance in henries is simply the number of lines of force multiplied by the number of turns in the coil and divided by 100,000,000 times the number of amperes.

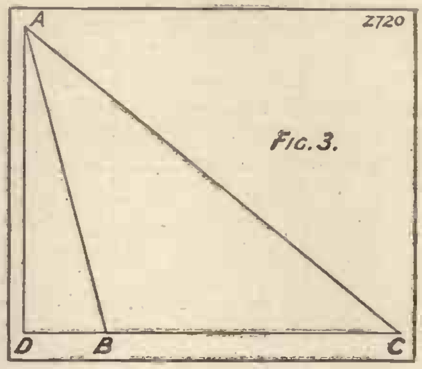
Given a permeability curve for the iron of the core (usually supplied by the makers) it is possible to calculate the inductance of a choke coil from the dimensions of the core, number of turns, current, etc. It is also possible, but not at all easy, to measure it. Both methods involve a certain amount of effort, which probably accounts for the fact that so few manufacturers can issue reliable information about their chokes or transformers.

Unfortunately there is still more in it than has been outlined. What has just been dealt with is the inductance with direct current, which is not what we want when considering wireless apparatus, which is concerned principally with alternating current (A.C.). For practical purposes the inductance of an air-core choke is the same whether the current is alternating or direct, large or small.

Even at radio frequencies the variation is usually quite small. But iron cannot follow the fluctuations of A.C. with the agility of air, and the higher the frequency the worse show it puts up. Even at low frequencies the effective permeability is much less than would appear from our curve.

Three Important Factors

For instance, with a D.C. (such as the steady anode current of a valve) which brings the iron core to a permeability of, say, 2,000, the effective permeability to the small A.C. corresponding to signals being amplified, or to hum being smoothed out in a filter, will be about 200. In addition, it depends also on the amplitude of the A.C. There are thus three main things that control the inductance of an iron-core choke to



A.C.—frequency, amplitude, and amount of direct current, if any.

The last-named is the most important, the first can perhaps be left out of account if one only considers telephonic frequencies—those that do business in the loud speaker—and uses good quality iron, good from a magnetic point of view. The amplitude can be roughly specified as being a fairly small fraction of the D.C.—a justifiable assumption in most cases with which we are concerned. It therefore appears that if a choke for use in wireless circuits is specified as so many henries at so much D.C., it will not be very far different for all usual conditions of use.

Effective Inductance

But how can we measure the *effective* inductance? It has already been explained how the inductance to the steady current has been arrived at, but that is no use to us when considering the design of a choke-coupled amplifier, a loud-speaker output circuit, or a "mains H.T." filter. Neither is it the slightest use to measure it on an alternating current bridge. The impedance of a coil to A.C. is made up partly of its ohmic resistance and partly of its reactance, which is $2\pi f$ times the inductance, f being the frequency in cycles per second. These two do not add up arithmetically, but if their respective magnitudes (they are both measured in ohms) are represented by two sides of a right-angled triangle, as in Fig. 2, then the impedance is represented by the length of the third side.

Now the impedance can easily be measured for it is simply the alternating voltage across the coil divided by the current through it. The resistance as measured by D.C. is usually so small that there would appear to be not much difference between the impedance and the reactance, so many have said that they can be assumed to be approximately equal, and the inductance consequently determined. However useful this method may be in some cases it is entirely false when applied to the present situation, as the resistance at A.C. is *not* even roughly the same as that measured with D.C.

A.C. Resistance

One is particularly badly had when a few turns are inadvertently short-circuited, as then the A.C. resistance goes up and the resistance goes down. It is quite necessary, then, to know the A.C. resistance as well. The only method of doing this which the writer has found satisfactory is to connect the coil in series with about 10,000 ohms of non-inductive resistance, pass the desired D.C. with a superimposed A.C. of about a quarter the amplitude, and with a valve voltmeter of a type unaffected by the steady voltage to measure the alternating voltages across coil, resistance, and both in series. A triangle is then drawn as in Fig. 3, in which the three measured voltages are represented to scale by the lines AB, BC, and AC respectively.

Then, if BC also represents 10,000 ohms (or whatever it is) AD to the same scale gives the reactance of the coil and DB the A.C. resistance. Although these two latter quantities will vary enormously according to the amount of D.C. present, the ratio of the two will be found to be very nearly constant with the usual types of chokes, provided there are no shorted turns; or, in other words, the power-factor is nearly constant.

The "Air" Gap

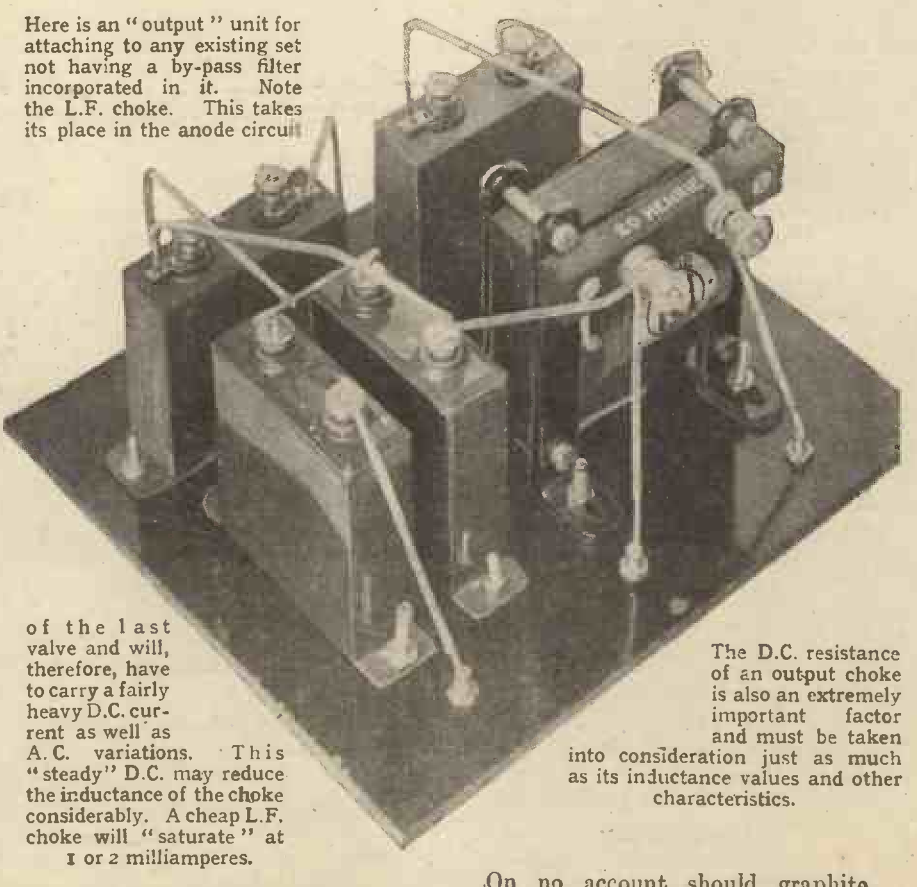
Finally, just a few words to clear up some misunderstandings about air gaps. Incidentally, any gap which is not made of iron is an air gap, be it paper or brass in actual fact. If a gap reduces so greatly the flux density, why is it an advantage? Well, if the coil is to be used without D.C., such as a small transformer for obtaining power from the mains, there is certainly *not* an advantage in a gap, but a very definite disadvantage, as more current is drawn to magnetise the core.

On the other hand, consider a filter choke to carry a relatively large D.C., yet to have as much choking effect as possible on the small superimposed ripple of A.C. If there is no gap the magnetising force is so great that the iron is saturated and its A.C. permeability is very small indeed. If this state of affairs is remedied by reducing the number of turns the inductance is again low for that reason, so the only alternative is to use an enormous core, which wastes both iron and wire.

But if a small gap, usually 2-10,000ths of an inch, is left in the magnetic path, most of the magnetic force is employed in overcoming the reluctance of the air, which never saturates, and a very large number of turns may usefully be employed. The inductance without D.C. is less than if there were no gap, but is fairly well maintained, whereas the no-gap choke would drop 9/10ths of its inductance when the D.C. came on, unless it were made uneconomically large.

A Serious Drop

It should be clear by now why certain chokes give disappointing results. One measured by the writer showed 25 henries by the usual method of test, but under quite possible conditions of use worked out at rather less than 2. It is therefore advisable to exercise some care in selecting such components, and a little consideration of the behaviour of magnetic circuits will be of considerable assistance in doing so intelligently.



Here is an "output" unit for attaching to any existing set not having a by-pass filter incorporated in it. Note the L.F. choke. This takes its place in the anode circuit of the last valve and will, therefore, have to carry a fairly heavy D.C. current as well as A.C. variations. This "steady" D.C. may reduce the inductance of the choke considerably. A cheap L.F. choke will "saturate" at 1 or 2 milliamperes.

The D.C. resistance of an output choke is also an extremely important factor and must be taken into consideration just as much as its inductance values and other characteristics.

A Lubricant for Drills.

By J. F. C.

Drills which are used for metal work do not usually require a lubricant, although some workers make a practice of dipping the tips of their drills in graphite paste just before they commence the drilling operations.

Drills, however, which are employed for ebonite working will perform their functions more easily, and will retain their businesslike properties for a longer period if they are now and again lubricated at their tips with a preparation made as follows.

Heat up a small quantity of candle wax and, whilst it is still molten, add to it an equal bulk of olive oil or castor oil. Stir the mixture well, and allow it to cool thoroughly. The mixture on cooling will have the appearance of an oily paste.

If the point of the drill becomes too hot, dip it in this paste. The lubricant will prevent undue heating and will preserve the point of the drill.

On no account should graphite lubricating pastes and preparations be employed for the purpose of lubricating ebonite drills.

The Regional Scheme

Present Position—Programmes—How the Midlands will Fare.

By the Editor.

THE problems and complexities of the Regional Scheme are so many and rumours and counter-rumours have been so numerous that it is not to be wondered at that a certain amount of confusion still exists with regard to the future plans of the B.B.C.

In the last issue of MODERN WIRELESS an attempt was made to analyse the Regional Scheme, and in connection with this article we have received many letters from listeners, particularly from those living in the Birmingham area and in the Midlands generally, and as a result of the article entitled "The Problem of the Regional Scheme," published in last month's MODERN WIRELESS, the B.B.C. has issued a statement of its intentions with regard to the matter.

Nothing Yet Definite

According to the B.B.C., continuous progress is being made with Regional Scheme experiments, but there is no doubt that the final plans will have to depend on the results of the Daventry experiments when they are concluded some time next August. Any Regional Scheme which is then finally drawn up will have to be approved by the Postmaster-General, and work upon the actual scheme is not expected to start much before the end of this year—and even then that cannot be guaranteed.

The B.B.C. hopes that the experiments at 5 G B will have so far progressed during 1928 that it will be possible before the end of this year to begin the erection of one or more of the new stations. But the B.B.C. frankly admits that at the moment everything is quite indefinite, and *the future of the Regional Scheme depends entirely on 5 G B.*

Recently, Major Gladstone Murray, a prominent official of the B.B.C., visited the Midlands with the express purpose of dispelling certain misapprehensions which had gathered with some force with regard to the place that Birmingham and the Midlands generally will occupy in broadcasting when the Regional Scheme comes into operation. There is undoubtedly a very strong feeling in the Midlands, and from the correspondence we have received from many of our readers in Birmingham and other districts in the Midlands there is no doubt that listeners are seriously concerned as to their future with regard to an adequate broadcasting service.

We are glad, however, to be able to reiterate on the strength of Major Murray's very definite pledge that whatever happens the Midlands will not be neglected, and that wherever the transmitters of the new Regional Power Stations will be situated in the future, Birmingham will not be forgotten and will undoubtedly be used as a centre for the artistic talent of the Midlands.

Birmingham's Status Assured

Major Murray has pointed out that it was undoubtedly because of the great success and efficiency of the Birmingham station that it had been chosen as the point of the experiments now being made at 5 G B, and there was no shadow of a doubt as to its broadcast status in the future.

Major Murray also stated that Great Britain had been allotted ten wave-lengths by the International Convention on Broadcasting—nine being on the broadcasting waveband and the other on the long wave-band as used by 5 X X. These will eventually be used, it is hoped, by five twin-wave stations, each of which will transmit alternative programmes. There has been, of course, a considerable amount of speculation as to the sites of these stations, but Major Murray made it quite clear when he said that "all statements or suggestions as to the actual siting of the transmitters are purely speculative."

Importance of 5 G B

The truth is that the B.B.C. has not yet gathered together sufficient data to decide where any one of the twin-wave transmitters is to be built, and until satisfactory statistics have been obtained from the Daventry experimental station, and until the necessary problems and deductions arising from the information collected have been dealt with, the B.B.C. engineers cannot even speculate as to where the transmitters are likely to be situated. But this may be taken for granted: that wherever they are situated Birmingham will have just as good a service and just as good a field strength as most other thickly populated centres in the country.

Major Murray has further pointed out that the universal programmes were those which would be broadcast from each of the Regional Stations simultaneously with its own Regional programmes, and would probably be transmitted to the Continent in connection with the simultaneous programmes being arranged with Continental broadcasting stations.

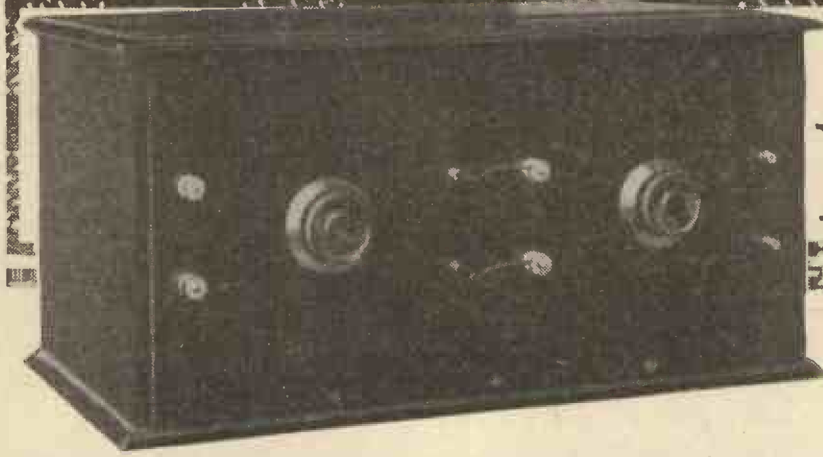
Major Murray has stated that so far as the maintenance

One of the studios at the Prague station.

of the prestige of any particular area is concerned, the important thing was not the geographical position of the transmitters but the retention and development of the local broadcasting organisation. He said recently that there was no reason for the rumours that had spread that the artistic resources of Birmingham or the Midlands were being ignored or were likely to be ignored in the future.

The future may show that it is not practicable for the

(*Continued on page* 109.)



The "Hi-Mu" Note-Mag

A novel and extremely useful L.F. amplifier which will give a choice of four combinations.

By L. H. THOMAS.

A LOW-FREQUENCY amplifier differs from most other pieces of radio apparatus in that it is possible to attain results that come extremely near to perfection. At any rate, a point can be reached beyond which there is no noticeable improvement to be made, however much work is put into the instrument.

With even such a simple set as an ordinary single-valver, there really never seems to be an excuse for being entirely satisfied with the results obtained, and one always seems to be able to "hit on" *something* that appears to be an improvement. Not so with the low-frequency amplifier, which, after having been constructed and adjusted to the owner's satisfaction, may be left absolutely alone and will come to no harm and continue to render faithful service.

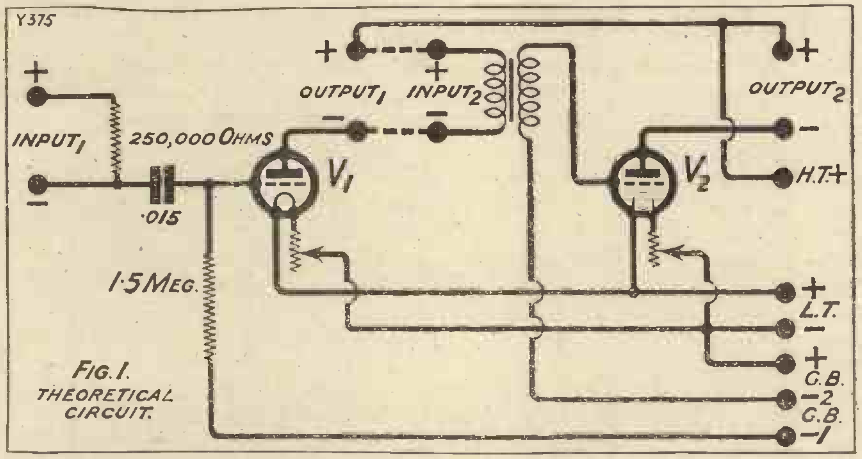


FIG. 1. THEORETICAL CIRCUIT.

The writer believes, when experimental work is concerned, in "cutting short" any set under test at the detector, and, when it is necessary to use a low-frequency amplifier, using always the same one, which is kept isolated from the other apparatus and "standardised." The amplifier described here has been in use for a very long time, and seems an excellent all-purpose instrument, which has never given any trouble or needed adjustment of any kind.

Two Separate Stages

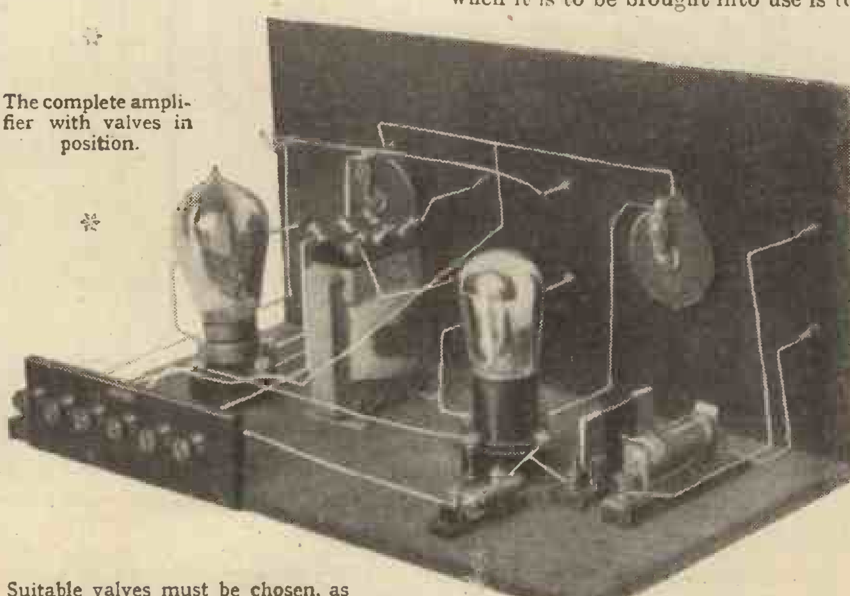
It consists essentially of two separate amplifiers, one being resistance-coupled and the other transformer-coupled, the two being housed in one cabinet (and one panel also being used) and arranged so that *either* stage may be used separately, or both together. Furthermore, either the resistance stage or the transformer stage may be placed first according to personal preference.

Such an amplifier as this, with the valves and batteries wired up, may be placed in an odd corner, the loud speaker being always connected to the output, and all that is necessary when it is to be brought into use is to

LIST OF COMPONENTS.

- 1 Panel, 16 in. × 8 in. × $\frac{3}{16}$ in.
- Cabinet for above with baseboard 9 in. deep.
- 1 Multi-ratio transformer.
- Wire-wound resistances of values required (250,000 ohms for ordinary purposes).
- 1 1·5-megohm grid leak.
- 1 ·015 mica-condenser.
- 2 Non-microphonic valve holders.
- 2 Rheostats of resistances to suit valves used.
- 1 Six-terminal strip.
- Terminals, sockets, wire, wood-screws, etc.

The complete amplifier with valves in position.



Suitable valves must be chosen, as described by the author on another page.

take a flex lead from the 'phone terminals of the receiver under test and connect it to the input terminals of the amplifier.

Flexible Arrangement

On this account, however, there is no need for the amplifier to be a "fixed" and inflexible thing; this has been guarded against by the provision of interchangeable resistances and condensers for the resistance-coupled stage and by the use of a transformer giving seven different ratios in the second stage. More will be said about the various adjustments later in the article.

The photograph in the heading shows the amplifier in the cabinet, with the two "straps" across the centre, in position as they would be if both stages were being used. The cabinet is of fairly large dimensions, since it is more important than is generally realised that the components even in a low-frequency amplifier should be well spaced.

Half the troubles that are put down to obscure faults in high-frequency circuits are probably due simply to instability in the note-magnifiers. The layout on the baseboard is consistent with that of the panel—the two stages are kept entirely separate but for the battery terminals.

Each "half" has two terminals for its input and two small sockets for its output, the filament of each valve being controlled by a rheostat on the front of the panel. The rheostats used should, of course, be of a make providing an "off" position, or a switch will be needed.

Connecting Up

Full details of the theoretical layout are shown in the circuit diagram, Fig. 1, and there is really no point concerning them that needs special mention except the fact that the positive input and output terminals are the upper ones of each pair. Care must be taken when connecting the

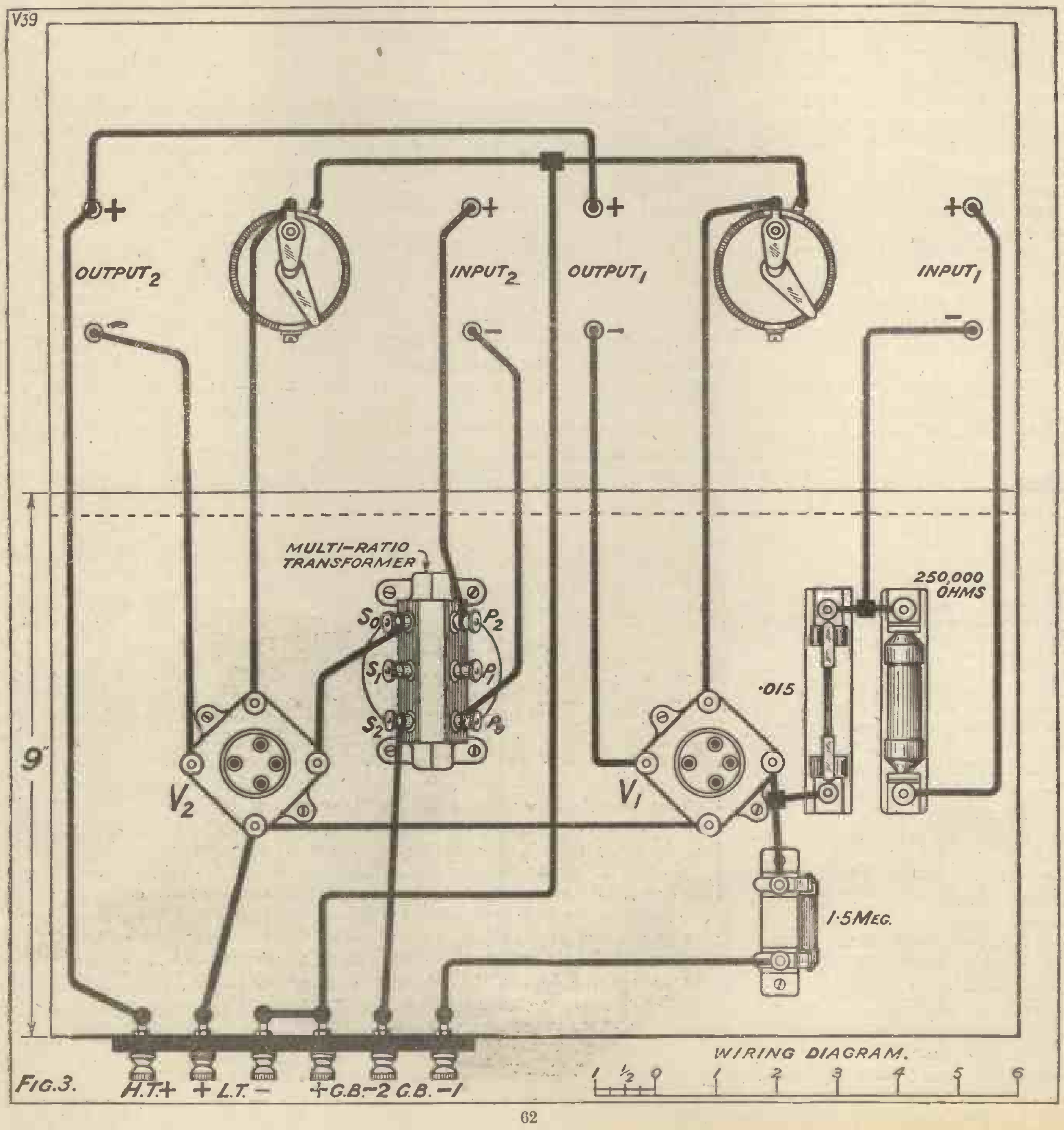


FIG. 3.

amplifier up to a valve set that the leads from the latter are correctly marked for polarity, the positive 'phone terminal (i.e. that connected to H.T.+) being connected to the positive input terminal.

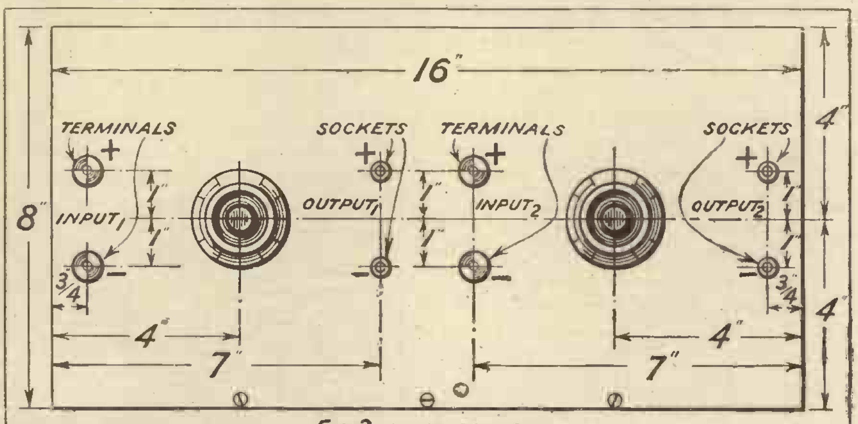


FIG. 2. PANEL LAYOUT.

No H.T.– terminal is provided, as it has been assumed that common batteries will be used for the amplifier and the set preceding it, and the provision of another H.T.– terminal might lead to undue complications.

About the actual construction and wiring of the set very little need be said on account of their extreme simplicity. *Both* the positive output terminals are connected to H.T.+, only one terminal for this having been provided.

It is fairly generally acknowledged to-day that the anode-bend method of rectification gives greater freedom from distortion than the leaky-grid-condenser method, and this was the chief reason for placing the resistance-coupled stage first in this particular amplifier. Excellent as an anode-bend rectifier may be in itself, it is nearly hopeless to expect perfect reproduction from a rectifier of this type followed by a transformer-coupled stage.

Pure Reproduction

On the contrary, a rectifier of this type with a resistance in its anode circuit is capable of giving what is probably the nearest approach to perfect quality, and the addition of a transformer-coupled stage *after* this is much more successful and liable to fewer disadvantages. The anode resistance should be of the order of 250,000 ohms (or even higher in some circumstances) and a high-impedance valve (60,000 ohms or so) should be employed as rectifier.

Another advantage is gained in this way, for considerably greater selectivity is obtained by using one of these high "mu" valves as rectifier on account of the high grid-to-filament impedance and the consequent reduction of the damping introduced into the grid and aerial circuits. It would not, of course, be feasible to use a valve of this type if it were to be transformer-coupled to the following stage.

The resistance normally used is one with a value of 250,000 ohms, with a grid condenser of ·015 mfd. and a grid leak of 1.

It is essential that the grid condenser should be of the mica type, and also important that it should be of good manufacture, since the most minute leak here will introduce a large amount of distortion into the whole stage by putting a positive potential on the grid.

Transformer Ratios

Whether the resistance-coupled stage is used alone or followed by the other stage the above remarks hold good.

With regard to the transformer stage, very little need be said except that too high a ratio should not be used when it follows the other note-magnifier. If the transformer stage is in use alone there is no harm in using a value of 4½ : 1, or, in some circumstances, even higher. With the resistance stage preceding it, the value used by the writer is either 2 : 1 or 1½ : 1.

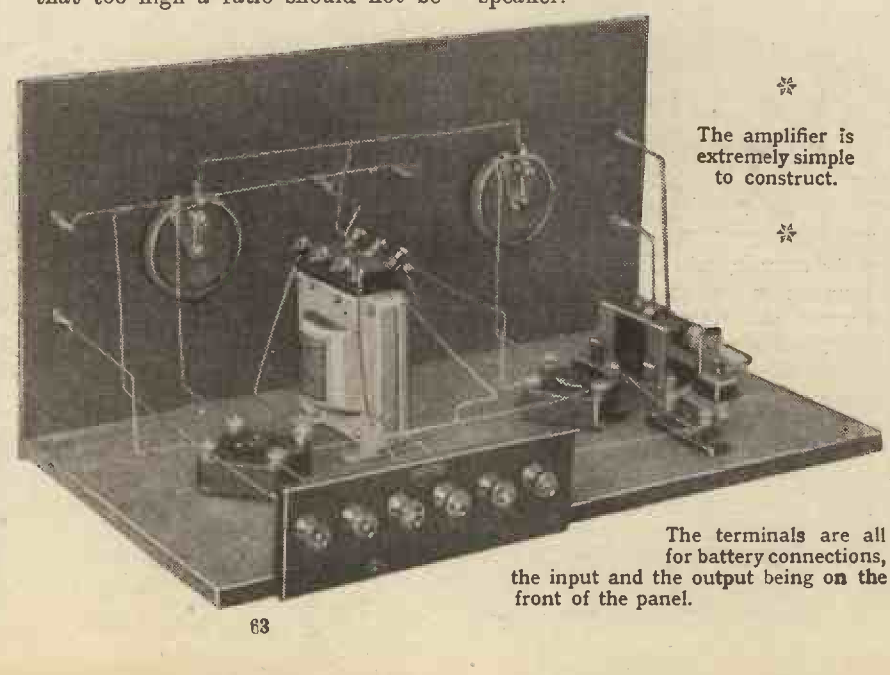
About 135 volts H.T. is used with both stages, although 90–100 volts will give perfectly satisfactory results. An ordinary power valve may be used in the resistance stage and a super-power valve in the other; but, of course, no definite rules can be given because of the number of different purposes for which the amplifier may be used.

The Output Circuit

One hint that will be found useful is this—when possible keep a milliammeter, reading from about 0–25, in series with the loud speaker or output, as a means of indicating distortion. The grid bias for each valve should be adjusted in conjunction with this, and results obtained will always be superior to those obtained by "hit-and-miss" methods.

The milliammeter should give an almost perfectly steady reading, and any "kicks" with an amplitude greater than about half a milliamp indicate the presence of distortion. No output circuit or output transformer has been provided, since it is usually preferable to connect this externally.

If a loud speaker of the "Kone" type is used, a step-down transformer will be found useful, although not essential. Incidentally, if such a transformer is used, the milliammeter should be wired in series with its primary, *not* in series with the loud speaker.



The amplifier is extremely simple to construct.

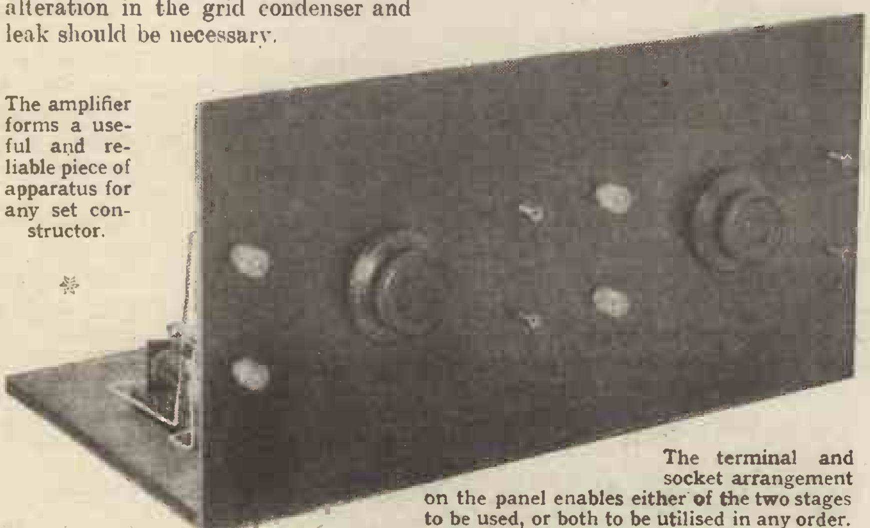
The terminals are all for battery connections, the input and the output being on the front of the panel.

A loud speaker can be worked perfectly satisfactorily on the local station (six miles away) from a single-valve receiver (an anode-bend rectifier with no reaction) followed by the resistance-coupled stage only, and the quality is beyond reproach. Unfortunately this is not quite so satisfactory with a "Kone" loud speaker, which does not seem to wake up until it is handling a current of the order of 20 milliamps—or, at any rate, something over 10 milliamps. The transformer-coupled stage, if brought into use after the other, supplies ample energy for this.

Grid-Bias Values

If the amplifier is to be used after a crystal receiver, the best plan is to connect the 'phone terminals of the latter to "Input 2," take "Output 2" to "Input 1," and connect the loud speaker to "Output 1." All this sounds very complicated, but all that has been done is the placing of the transformer-coupled stage in front of the other. A high-impedance valve should therefore be used in the transformer stage.

It may be found that a lower value of resistance will be beneficial in these circumstances, and one of 100,000 or 150,000 ohms may be substituted. No alteration in the grid condenser and leak should be necessary.



The amplifier forms a useful and reliable piece of apparatus for any set constructor.

The terminal and socket arrangement on the panel enables either of the two stages to be used, or both to be utilised in any order.

As regards grid bias, it is a good rough rule to remember that the correct value is approximately the H.T. voltage divided by twice the magnification factor of the valve. Thus, with a valve having a "mu" of 6 and an H.T. value of 120 volts the correct value of grid bias is roughly $120 \div 12 = 10$ volts. This refers, of course, to the H.T. voltage *reaching* the valve, not necessarily to that applied by the battery, for there is a voltage drop in the anode circuit.

A REINARTZ AT FAULT.

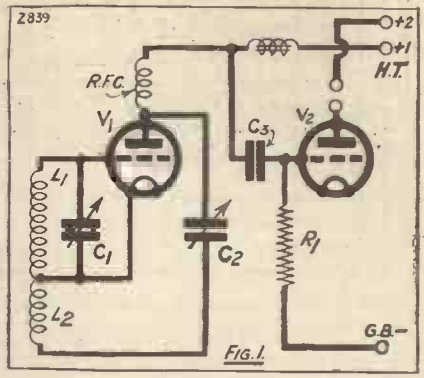
By H. J. B. C.

A SET had been working perfectly when suddenly, in some uncanny manner, the volume emanating from the loud speaker was reduced to about half normal, while the music was distorted in a most unpleasant manner.

The set in question was a commercial two-valver, embodying the familiar Reinartz reaction, and the skeleton portion of the circuit, shown in Fig. 1, gives the essentials and will be useful for reference purposes. Before tackling the set I assured myself that all the accessories were above suspicion—the aerial-earth switch contacts clean, aerial, down lead and earth wires intact, low-tension battery up to scratch, and the high-tension battery satisfactory, with all wander plugs making efficient contact. This preliminary search brought nothing to light, so the valves themselves were next subjected to a critical examination and test, only to prove that it was not in this direction that any trouble lay.

Attention was finally focussed on the set itself, and the usual routine tests for continuity, proper insulation, etc., undertaken with meticulous care, but all apparently to no avail, as the set gave absolutely no indication of defects. It was accordingly reconnected to the batteries and aerial and brought into commission. At first all seemed well, but at the end of a quarter of an hour a recurrence of the trouble took place, namely, reduction in volume accompanied by distortion of signals. Adjustments on the reaction condenser C_2 failed to restore the original volume, and adjustments on the grid-bias battery failed to cure the distortion.

I strongly suspected the high-frequency choke connected in the anode circuit of V_1, which I subjected to a high-frequency test. My suspicions proved justified, for at high

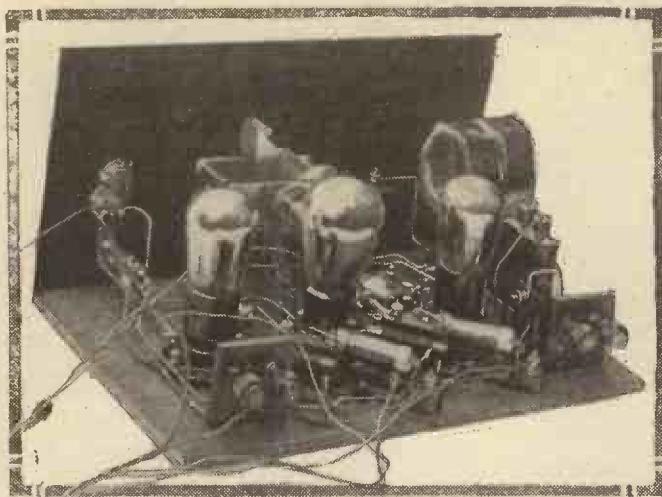


frequencies the choke showed a bad leakage. This was found to be due to imperfect insulation between wire turns coupled with an impregnation by a dope made up to a wrong chemical formula. Replacing this choke with another which I knew to be sound resulted in a restoration of the signal volume to its full intensity, with the usual smooth reaction control characterising a Reinartz receiver properly adjusted.

A "Dud" Grid Leak

The distortion was not cured, however, so in this case I resolved to measure the resistance of the grid leak R_1 used in the grid-bias circuit of the choke capacity-coupled low-frequency valve. Although rated at one megohm, the value proved to be anything between ten and twenty megohms. The result of this is plain to see. The remedy was obvious, and a replacement of this component with a grid leak made by a firm of repute cured the trouble, and it is now working perfectly.

My object in recounting the experience to readers of this journal is to emphasise the importance of making sure that all the components used in a receiver, commercial or home constructed, are of the best quality, otherwise it comes down to "spoiling the ship for a ha'porth of tar."



The LOCAL STATION PROBLEM

Distortionless results are not very difficult to obtain, as our contributor shows in the following article on "local" receivers.

By P. C. BAKER.

LET me assure you before you turn over the page and say, "Another article on wave-traps," that the aspect of the local-station problem which I am going to deal with here is not one of interference at all. It is, rather, a question of handling the signals on the low-frequency side.

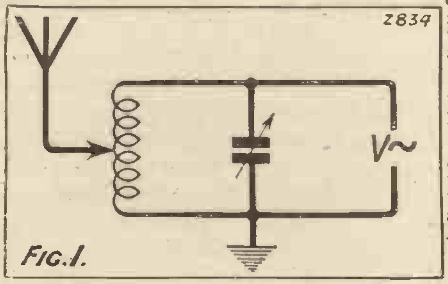


FIG. 1.

The average wireless receiver designed for the reception of broadcasting is a compromise, for very few people care to go to the trouble or expense of building two special receivers, one for distance work and one for the local station.

Making Allowances

There is no doubt in my own mind that this necessity is a very real one, and although some listeners are beginning to wake up to the possibility of this being so, many are not really convinced. I trust, however, that the following details as to some recent experiments may succeed—to their advantage—in converting a few on this point.

The average wireless receiver is quite all right when dealing with fairly small inputs such as are obtained from distant stations, and it is further assisted by that very human failing of "making allowances."

Thus the listener is content with a degree of volume from distant stations which is considerably below the standard he expects from the local transmission, for he subconsciously says to himself, "That is jolly good for a station 200 miles away."

When working on the local station, however, he expects his receiver to be able to handle the full volume, and then when the set is overloaded he complains that the quality is poor and accuses the B.B.C. of giving bad transmissions.

Daventry Distortion

Well, we all know that this sort of thing will occur in the best of regulated families and that transmissions from the B.B.C. do occasionally suffer from slight indispositions.

For instance, there is that unfortunate dither on their piano transmissions during the Daventry weather forecast which they have so far failed to eliminate.

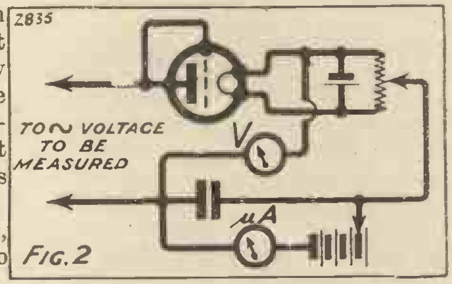
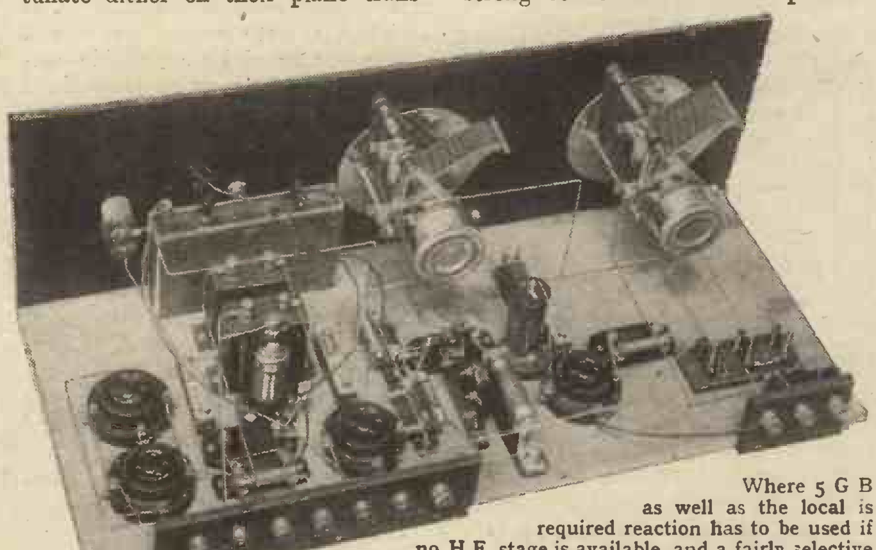


FIG. 2

In eight cases out of ten I think, however, that this distortion is due to overloading in the receiver, the ninth case being due to interference from the powerful transmission of Leipzig on 365 (?) metres.

Let us examine a 2-valve circuit consisting of a detector and L.F. and see just where and why a strong local transmission will produce



Where 5 G B as well as the local is required reaction has to be used if no H.F. stage is available, and a fairly selective tuning circuit must be employed, while paralleled output valves are advisable.

distortion. We shall be assisted in this if we know what voltages the valves are called upon to handle.

Although the figures which I am giving are the result of measurements taken within a mile of 2 L O, they will hold up to considerable distances from this station, since at this close distance the wave-front has not properly formed, while reception in Town is, of course, much worse than farther out owing to absorption by buildings, telephone wires, etc. I am of the opinion, therefore, that the figures which I give will hold up to perhaps five or six miles of 2 L O with a fair degree of accuracy.

Valve Voltmeter Measurements

Since I am attacking this problem from the point of view of obtaining distortionless loud speaking from the local station, I am going to use anode-bend rectification in the detector circuit. The first consideration, therefore, is what H.F. voltage do we apply between grid and filament of the rectifier valve.

Measurements taken with a valve voltmeter show that this may be anything up to 12 or 14 volts when not using H.F. stages. This, therefore, has the effect of applying a fairly high value of positive potential to the grid of the valve, owing to the fact that this is rectifying, so that a far larger value of negative bias has to be used on the grid than would be required for a very small H.F. input, a point to remember when operating a receiver using anode-bend.

Further, since we are using anode-bend rectification it is important that we should keep away from grid current—i.e. that the H.F. signal voltage which is applied to the grid of

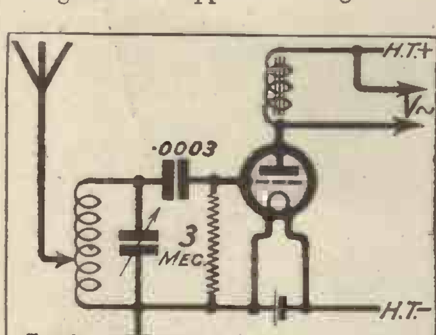


FIG. 3.

the detector valve should at no time make the grid positive, otherwise grid-current distortion will result.

This means, therefore, that we must have a sufficient straight-line portion on the negative side of the zero grid-volts' line to handle the H.F. voltage applied. This means, therefore, that the detector valve and the coupling used between it and the first L.F. stage must be suitably chosen and a sufficiently large value of H.T. employed to ensure that no distortion will occur owing to detector overloading.

Modulation Voltages

This, luckily, is not, however, so great as would at first appear from the figures as to the H.F. voltage applied to the grid. This voltage is due to the average value of the carrier which has the result of applying a steady positive potential to the grid.

The fluctuating voltages which control the grid as far as rectification is concerned are due to the modulation of the carrier. I believe the modulation at present employed is not greater than 40 or 45 per cent, aud it is, therefore, feasible that the possibility of

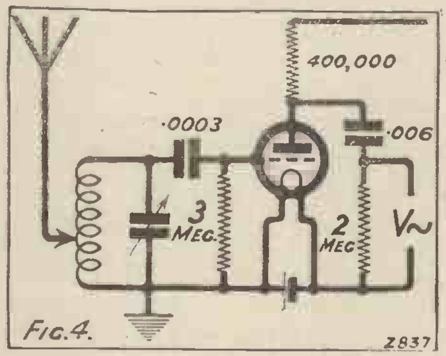


FIG. 4.

overloading the detector valve, providing that suitable coupling and plenty of H.T. is used, is not great.

Incidentally, some interesting figures on the efficiency of various types of coils were obtained when taking these signal-strength measurements. The aerial was auto-coupled to a coil which was tuned by a variable condenser, the voltage across the ends of the coil and condenser being taken as shown in Fig. 1.

Testing Coils

Using an extremely low-loss coil and a highly efficient condenser, the maximum voltage of 14 volts was obtained when tuned-in to the local station. In view of the fact that the valve voltmeter employed applied practically no damping at all to the tuned circuit, the tuning was found to be extremely sharp and critical and considerable care had to be taken in taking the readings.

An average efficient coil gave an H.F. voltage of 6–8 volts, but when a commercial tapped coil was used in place of the low-loss coil the signal voltage fell to 3 to 4 volts.

Connecting a valve-holder across the second tuned circuit used caused a decrease in signal voltage, owing to the dielectric losses present in this

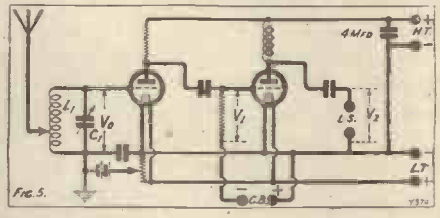


FIG. 5.

component, from 6·8 to 6·4 volts, and the insertion of the valve caused a further drop.

When the valve was turned on the voltage fell again and was a particularly large drop in this case, no doubt owing to the fact that leaky grid-condenser rectification was used. A drop was also obtained when using anode-bend rectification, though it was not so great as with leaky grid.

Another Scheme

Various types of coils were tried out, and some interesting figures obtained from them. I do not, however, intend to deal with these here, as I am continuing my experiments on this point in other directions.

Probably a simpler method of examining the problem is from the output side of the detector by measuring the audio-frequency voltage variations which are produced in the plate circuit of the detector valve, and then by an examination of the characteristics we can see whether the straight-line portion of the characteristic line between the zero grid-volts' line and the lower bend at which rectification takes place is long enough to handle this voltage swing without distortion, providing that we know the effective plate voltage of the valve when actually in use.

Measurements taken on my aerial at one mile from 2 L O gave the audio-frequency output voltage from the detector valve as being in the neighbourhood of 16 volts with the commercial tapped coil.

Reasonably Accurate

It may be of interest here to give brief details as to the method employed in measuring these voltages. A valve was used with the grid and plate connected so as to form a diode. The plate voltage of the valve was then adjusted by means of a local battery to a potential at which plate current was just beginning to flow, and this plate potential was noted.

The valve was then placed across the source of signal voltage and the plate voltage readjusted till a position was found at which the current was just beginning to flow again as before. The difference between the two potentials required to give this condition was, of course, half the potential of the H.F. or L.F. voltage generated across the tuned circuit. The method is accurate within about five per cent, and Fig. 2 shows the theoretical circuit.

Points to Remember

It should be noted that this is half the peak value of the signal voltage, since only the positive half cycle affects the arrangement employed, and all readings must, therefore, be doubled. The figures I give are actually the total voltages.

If R.M.S. values are required for any purpose, the figures obtained must be multiplied by $\frac{1}{\sqrt{2}}$

It should be remembered, however, that the valve is sensitive and responsive to the peak values.

A further point to remember is that the average peak voltage of an audio-frequency signal, which, we will say, is 5 or 6 volts, may nevertheless have present optimum values far exceeding this figure. These may either be due to very loud passages or to certain notes which will give rise to high voltages on the grid.

These optimum values may exceed the average values by 50 or 60 per cent.

Let us see what all this means in actual figures. Suppose the average peak signal voltage applied from the detector to the grid of the first L.F. valve is 2·5 volts. Let us suppose, further, that this L.F. valve is coupled by resistance-capacity coupling to the next L.F. valve under conditions which allow it to handle a total grid swing of 3 volts.

Overloaded Without Reaction

Now a 2·5-volt output swing from the detector is the average peak value. We have to allow for at least 50 per cent optimum swing on certain notes and loud passages which, therefore, brings up the total grid swing that the L.F. valve will have to handle to a figure of 3·75 volts.

We are, therefore, applying a voltage swing to the grid of the L.F. valve which is considerably greater than that which it can handle without distortion, though the difference may not be great enough to cause audible distortion, since the average resistance-capacity valve does not run into grid current until after the grid becomes about ½ volt positive, while the bottom-bend rectification which will take place may be too little to have any appreciable effect, except for frequencies at which the output impedance of the valve is very low.

I found by measurement, however (as previously stated), that the audio-frequency voltage output from the detector valve was from 15 to 19 volts on the local station under quite unfavourable conditions.

These figures were obtained, of course, without the use of reaction, since the amplification given by reaction is very great indeed.

Ascertaining Values

This value was obtained by measuring the signal voltage across an L.F. choke having an extremely high impedance connected in the plate circuit of the detector valve, as shown in Fig. 3.

It was first of all necessary to compensate for the D.C. voltage drop across the choke owing to its resistance, which, of course, gave a reading on the voltmeter. Luckily, since the D.C. resistance of the choke was low the voltage drop across it was very small, as a high-impedance detector valve was used.

This reading, therefore, gives the audio-frequency voltage component present in the plate circuit of the detector. We are most interested, however, in the voltages which are applied to the grid of the next valve, and I therefore measured the voltages on the output side of various coupling units.

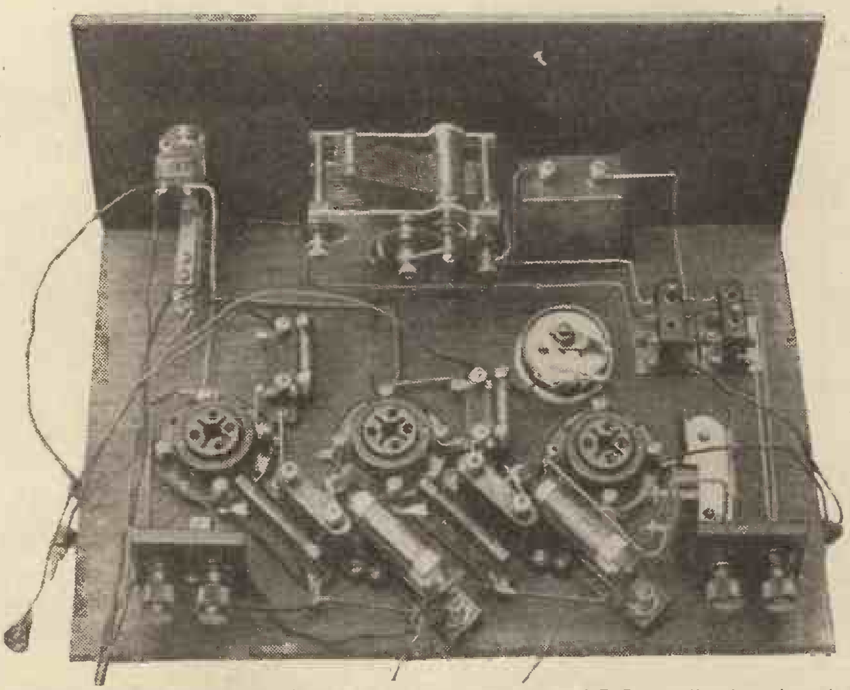
A Transformer Test

Using a resistance-capacity coupling unit (Fig. 4) with a high value of anode resistance (in the neighbourhood of 400,000 ohms), with a resistance-capacity valve of the same type as used in the Fig. 3 circuit, an increase in signal voltage was obtained which was no doubt due to the valve working under more favourable conditions when having a high resistance in the plate circuit.

The value obtained was from 19 to 21 volts in this case. On substituting a high-mu resistance-capacity valve, using anode-bend rectification for the detector, the voltage obtained across the output terminals rose to a value of 22–24 volts.

These values are those which caused an occasional slight movement of the valve voltmeter needle, but maximum values were obtained from time to time which exceeded these figures by over 40 per cent.

The next readings were taken with an L.F. transformer of efficient design connected in the plate circuit of the detector valve, and the signal voltage across the secondary of this transformer was measured. The particular instrument used was connected to give a ratio of 3·5 to 1, and



A receiver utilising an anode-bend detector and two stages of R.C. coupling is eminently suitable if used close to the local station.

a signal voltage of 40 volts or over was obtained.

The signal was listened to with a pair of phones at the same time as the readings were being taken, and some rather interesting points were noticed as regards those features of the transmission which gave rise to the biggest output voltages.

In speech it was found that the consonants " E " and " O " if spoken at all above normal pitch produced a decided kick in the meter, and it was found in general that high values of output voltages were more common in speech than among musical items.

Curious Facts

An organ recital was listened to almost immediately after the speech, and notwithstanding the fact that the total volume of sound was far greater than that given during the talk, a lower average voltage was obtained on the audio-frequency side.

Curiously enough, it was found that those notes which produced the biggest swing of the meter needle were not the high notes, as we are always led to believe, but the low bass notes and even the pedal notes on the organ. These were perfectly clearly audible in the telephones and they were certainly being amplified by the transformer. Nor were they shadow notes built up by harmonics, but very definitely fundamental tones.

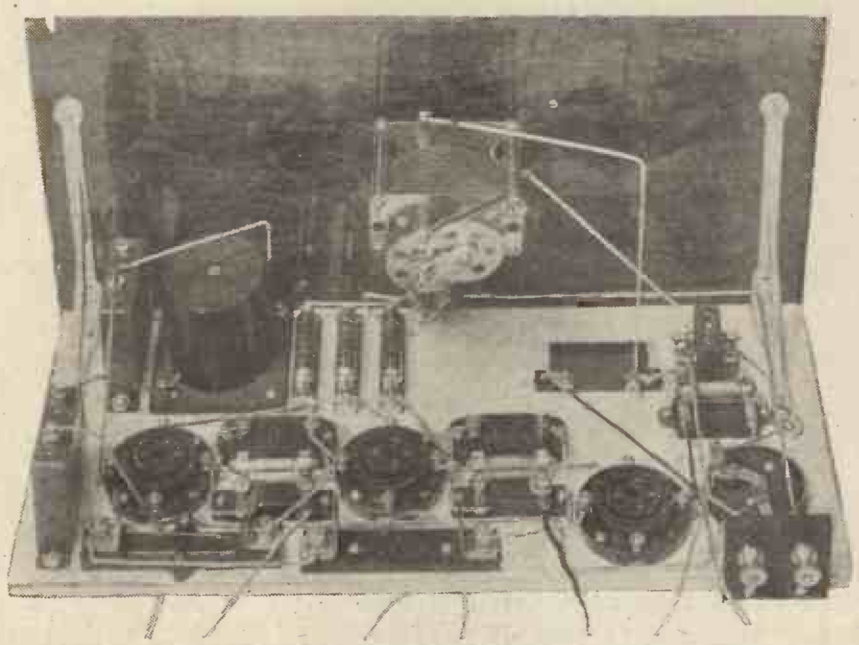
A further set of readings was now taken in which an efficient tuned circuit was employed in conjunction with a high-mu detector valve, using anode-bend rectification and resistance-capacity coupling. The circuit is shown in Fig. 5. Measurements were taken of the H.F. voltage across the tuned circuit L_1 C_1 as shown at V_0, while the audio-signal voltage applied to the grid of the L.F. valve was measured as shown at V_1 and the fluctuating voltage across the loud speaker measured as shown at V_2.

Interesting Figures

The tuning inductance L_1 consisted of 40 turns of 24 D.S.C. copper wire spaced 1 diameter and wound on a 4-in. Paxolin tube. Tappings were taken at 3, 6, and 9 turns from one end to which the aerial could be attached.

This was tuned by a ·0005 low-loss condenser incorporating a slow-motion control. The two valve holders for the detector and L.F. valves were of anti-capacity low-loss type in which the minimum of dielectric was contained between the valve legs.

The resistance-capacity coupler was a unit specially designed for use with a high-mu valve of the type used in the detector position. The L.F. valve used a choke circuit filter so that no D.C. flowed through the loud speaker, while the H.T. tapping was shunted by a 4μF condenser.



A three-valve R.C.-coupled receiver with grid-leak and condenser rectification.

The first measurement to be taken was across the tuned circuit L_1 C_1, and with the detector valve turned out the H.F. voltage, V_0, so obtained was between 13 and 14 volts. With the detector valve turned on and adjusted so as to be rectifying most efficiently the voltage dropped to 10 volts.

On taking a voltage reading, V_1, across the input of the L.F. valve, readings of 38 to 44 volts were obtained, and even at the maximum value kicks on the voltmeter needle were occasionally obtained on speech or certain notes in music. This value was obtained with the L.F. valve switched out.

When the L.F. valve was switched on the voltage dropped to about 30 volts.

Further Curious Effects

The first measurements of the voltage V_2 across the loud speaker gave readings between 120 and 140 volts, and this is what we would expect since the last valve has an amplification factor in the neighbourhood of 3 with an input voltage of 36 to 44 volts.

It was found, however, that on certain notes to which presumably the loud speaker presented an extremely high impedance, the L.F. voltage across this instrument rose to a value of 180 or 190 volts.

We now have a somewhat curious case here, for assuming that the last valve is being worked under conditions of high-tension and grid bias where a maximum grid swing of 44 volts would not cause either grid current or bottom bending, we are still in the position of having an overload in the plate circuit owing to resonance effects in the impedance which is connected in this position.

Overloading the First L.F.

The result is that, though no overloading is obtained on the input side, overloading on the output side is certainly resulting owing to these resonance effects giving rise to large fluctuating voltages in the plate circuit, larger indeed than the valve can possibly deal with *since these fluctuations actually exceed the value of plate potential applied to the valve.*

I think that the above figures will make it fairly clear how easy it is to overload even a big valve in the first L.F. stage when working on the local station. Certainly these readings have been taken at very close distance from the local station, but I do not think I shall go far wrong in saying that a special receiver should be used for the local station, designed so as to handle the very large voltages which are obtained and that the greatest care should be used in selecting the circuit and components for use with it. Above all a sufficient value of high-tension should be available to prevent the L.F. valve or valves from being overloaded.

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My Broadcasting Diary

Under this heading month by month our Broadcasting Correspondent will record the news of the progress of the British Broadcasting Corporation, and will comment on the policies in force at B.B.C. headquarters.

New London Transmitter

ALTHOUGH the beginning of 1927 saw the introduction of the Corporation and the passing of the old Company, there were singularly few changes in the Broadcasting service and organisation throughout the year. This year, however, is likely to see many and far-reaching changes.

The new London twin-wave high-power transmitter should be in operation. 5 G B will probably disappear; but the threat of this is already causing such uneasiness that the B.B.C. may well allow it to remain for another year or so. To take 5 G B away before the Midlands is properly served would raise a violent storm of indignation. Incidentally the B.B.C. is formally pledged not to let the Midlands down.

Empire Broadcasting

Although the reports of some of the early transmissions of 5 S W are disappointing, there is still a substantial progress to record. It is now fairly obvious that varying wave-lengths must be employed in addition to spaced-aerial reception. The latter is being simplified considerably by the newly discovered fact that aerials placed at right angles, horizontal and vertical, have much the same steadying effect as aerials placed in parallel but at some distance from each other.

By next autumn the B.B.C. should have evolved satisfactory service conditions. If this is the case, then the programme organisation of the Empire service must receive early attention. It is to be hoped that Savoy Hill will not neglect this end of the Empire enterprise. The programmes will require close and intelligent supervision. Captain Ian Fraser and Mr. Gerald Marcuse are freely mentioned as the obvious people to handle this service successfully and imaginatively. Their appointment would be generally popular, and would more than restore the prestige of the B.B.C. lost earlier in 1927 when it declined to co-operate with the amateurs on Empire work.

European S.B.

The European S.B. system should be completed and in regular working order by the end of 1928. The influential German delegation of broadcasters which has recently visited this country undertook full co-operation in Central Europe. This was all that was required to make the scheme a practical proposition. The B.B.C. programmes will be greatly enriched by the regular addition of the best material produced by Continental broadcasters.

Programme Development

1928 is certain to see a restoration of " peaks " to the B.B.C. programme system. Savoy Hill has wisely responded to the suggestions of friendly critics, and is now at work devising ways and means to get rid of the standardisation menace which has raised its head too prominently during 1927. Machine-like efficiency has distinct drawbacks in matters of art. Important staff changes are taking place.

Already Mr. B. E. Nicolls has moved from the London Station to another department, and Mr. Rose-Troup has

Graham Amplion public-address equipment installed at a London cinema. Animal noises were projected in synchronism with a film.

been imported from Bournemouth to take the much-coveted London position. Other changes are imminent, probably affecting the main part of programme administration. It is believed that Cecil Lewis is almost certain to return, with A. Corbett Smith as his lieutenant. It is rumoured that this move is supported by Captain Eckersley, the "Warwick of broadcasting." If this comes to pass, then Captain Eckersley's brother will probably follow Mr. Nicolls into the information end of the business.

Administrative Changes

There are persistent rumours of the impending departure of Sir John Reith from Savoy Hill. This is a matter of the gravest concern to all who know anything about our broadcasting service. But it stands to reason that one who is superlatively a retriever of lost causes and a restorer of shattered fortunes should begin to get restless when the business he has created runs along so smoothly that there is not enough to satisfy his immense craving for work.

I would hazard a guess that Sir John will not leave the B.B.C. until about the end of 1928, or in the early part of 1929. Meanwhile, however, he will be so organising the work there that he will feel some assurance that his going will not precipitate a catastrophe. The appointment of a successor to Sir John is freely discussed at Conservative Party headquarters, where the job is looked upon as one of the best of the patronage plums.

The consensus of opinion in Conservative circles is that the post will revert to a junior member of the Government following a Cabinet reshuffle. But there is a good deal of "counting chickens before eggs are hatched" in much of this speculation. The country will not stand for the position of Director-General of the B.B.C. being turned to account purely for party patronage purposes, whatever the party. Then, again, Sir John is so closely identified with all that is best and distinctive in B.B.C. tradition, that the efforts of the Government should be devoted to holding him in the job for at least another five years.

The huge motor-generator room of an American broadcasting station. W E A F's new 50-kw. plant is situated at Bellmore, L.I., N.Y.

Controversy

Although the B.B.C. has been quietly gaining a little ground in the controversy war, listeners are still dissatisfied with the rate of progress. The coming year must see a definite facing of the issue in Parliament. I anticipate a considerable relaxation in the attitude of the Government, which is at last realising something of the determination of the public not to be deprived of the delectable salt of controversy.

By the end of the year it should be possible for the B.B.C. to have any current subject discussed before the microphone. This will be a tremendous gain, and should give a fillip in licence figures. These are slowing down markedly, and unless novelty and new material are made available, there will be a considerable falling off in 1928.

Helping the Trade

There are signs that the B.B.C. means to do something decent to help the wireless trade next year. This help will take the form of talks directly inciting people to purchase British wireless apparatus, as well as talks about how to use receiving apparatus. Captain Eckersley is instituting a series of monthly talks in which he will not only educate the public in the regional scheme, but will deal with problems and aspects of reception, after consultation and in agreement with the wireless trade, through the R.M.A.

B.B.C. Revenue

When the P.M.G. makes his report to Parliament in March about broadcasting in the first year of the Corporation, he will be closely questioned about the large sums being retained from licence revenue by the Treasury.

This was no less than £900,000 at the close of 1926, and is now in the region of £1,400,000. These figures refer to balances after the cost of collection has been deducted.

Apparently it is the intention of a harassed Treasury to make still further inroads into B.B.C. funds, and to try to count on a steady £600,000 a year clear profit from this source. They are prepared to encourage the B.B.C. to launch out into a lot of profit-making subsidiary businesses in order to make this annual raiding possible.

Parliament will have to keep a jealous eye on the intrusion of broadcasters into other fields to the disadvantage of legitimate trades working under competitive conditions. Publishing is already serious. Manufacturing is freely canvassed in the background. If the B.B.C. went into the mass production of wireless apparatus, it would ruin what chance the wireless trade has of getting back the money it has risked as a test of faith in the early days of broadcasting. It is to be hoped that, with all the outside attractions in the form of publishing and other sources of revenue producers, the B.B.C. will not lose sight of its raison d'être, that of acting as a public servant in the matter of the provision of broadcast programmes. It would seem that in the tendency to develop into a glorified stores, the personality of one of the most important public concerns is liable to be lost.

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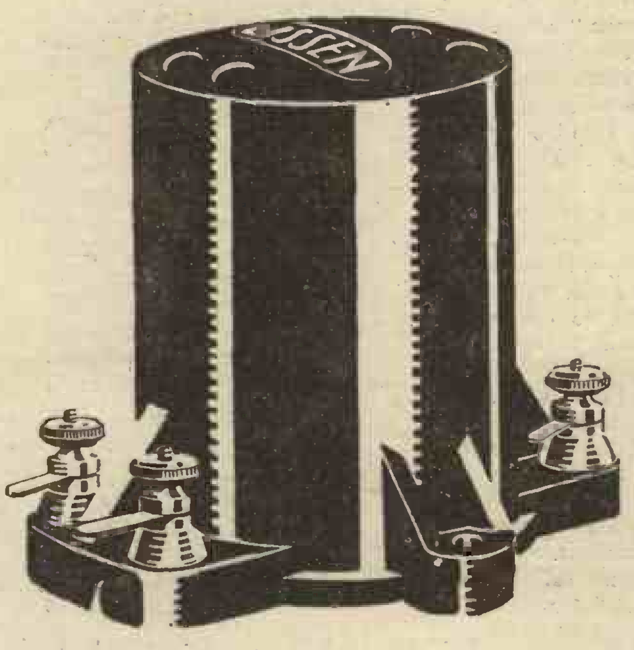

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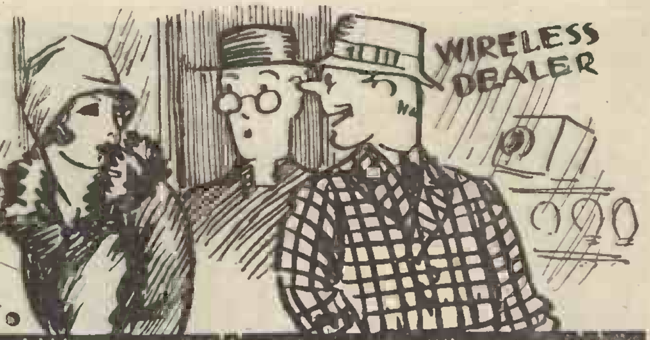


This New Year's Resolution stuff is a positive nuisance, just as bad as "fading" and the B.B.C.'s half-starved string quartettes. It comes all over me after breakfast on New Year's Day and bites old man Conscience savagely for the rest of the day. Then, when I have had time to think it out, I make my one great annual good resolution. It is a

"—and now Bill Bolton goes home to Brixton and moves a little handle round . . . and hears the 'diggers'!"

bad one, and reads as follows: "No Change."

I dislike the idea of change as heartily as the female bandits who hold you up in the street on "flag days." It is no good for me, as well I have learned. Once I changed my valve merchant, and was punished by getting a sort of chameleonic valve; sometimes it was blue, sometimes it wasn't, sometimes it was tartan, and in the end it went black.

Too Much Science

Once I heard of a man who resolved to cultivate habits of scientific precision; to have done with his old slack ways and to introduce *measurement* into his dealings with radio. I think he had been reading one of those American magazines and had seen that famous advertising war-cry of the Lackawanna Li-eesy Meters, Incorporated, "Watch your Watts and save Big Money." Anyhow, I believe he mounted on the panel of his set an example of almost every known meter except a petrol gauge, a pedometer and a gas meter, and it is recorded that once he was so scared at seeing the number of watts he was using that he switched off in the middle of "Love's Old Sweet Song," and thereby so embittered his Aunt Maria, who was keeping time on the fender with her toe, that she knocked up her solicitor at 10.50 p.m., and dictated a codicil to her will which hopelessly destroyed her nephew's chances of retiring at thirty-five and making a pilgrimage to Miami Beach (W I O D).

Then there was the sad instance of Butler. One Jan. he madly resolved to make himself a master of wireless theory, so that he could put it across that insufferable pedant, Stroggs, B.Sc., who daily bored the end "smoker" on the 9.5 "up" with his superior talk about "heterodyne envelopes" and "coefficients of noise." Alas, what condign fate befell Butler. He began to draw curves. That is the first step leading to the notorious steep and slippery slope which ends in lunacy. Before long he was able to describe a *concerto* in terms of differential calculus, and state the case of a prolonged blare on a saxophone as a function of space, using μ as an operator, to eleven places of long-distance logarithms. Eventually he got to using language which would scare a Professor of Chemistry into regular church attendance; so he was snubbed by the vicar, and his wife ran away with a french-polisher.

Parallel with the resolution bug runs the Diary-keeping Distemper. Is there a man of us who has not suffered from it? My one effort lasted till March 13th. Then I tore out all I had written, blushed, burnt the leaves, and gave the diary to my six-year-old boy, who joyfully filled it with pictures of "old men," and steam engines with only two wheels but lots of smoke.

Holy Thoughts

I began by recording high and holy thoughts — subconsciously cribbed from my desk calendar at the office. "A scratch in time saves a pimple" (*Anon*). "Take care of the pence and the Jews will look after the pounds" (*Marcus Aurelius*). "Jazz and the world jazzes with you; waltz, and you waltz alone" (*Queen Victoria*), and so on. As I grew weary in well-doing my entries grew briefer, until I came to recording merely the names of the B.B.C. artists who I did not like. My last entry was, "That goat Proshka again, and his infernal quartette."

The Diary Fiend

There is a fellow in Tooting who has diaries covering five years, full of the call-signals of stations he logged each day. Two hundred years hence, if those diaries are found, the professors will think they have discovered another Pepys and will drive themselves dotty trying to decipher the code in the hope of uncovering a record of scandal second to none.

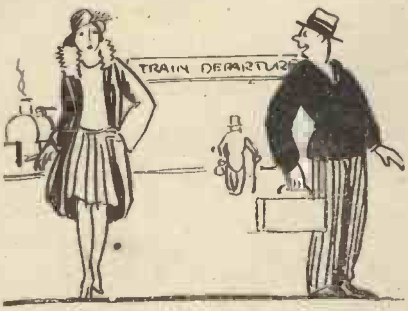
But lest you should think I am going out of my way to discourage introspection and the self-reformation of evil persons, by crabbing good resolutions and diaries, I beg to remark that the more the merrier—of both. But not for me, that's all. When I feel a good resolution hotting up, I "make" it on the spot. I find that this renders it much more comfortable to break the resolution

"Now things like that written into diaries ought to make good reading."

shortly afterwards, for resolutions registered on birthdays and New Year Days make a horrid crash when on the point of dissolution. And as for diaries, Letts have plenty. I really do mean, *let us* have plenty. When a man is cudgelling his brains to recollect what he did during the day worth recording, he is out of mischief; can't oscillate, can't keep me awake

with his loud speaker, can't write "expert" notes on radio for the Lingly-on-the-Wold "Weekly Advertiser," and can't play the concertina in front of the microphone.

As a matter of fact, I think every radio man, except me, ought to keep a diary, because I believe that much listening tends to make a man lose originality, just as much reading does, and the little nightly dose of diary will make a man use his own noddle. Nightly, did I say? Bless you, I used to let the thing rip for weeks together and then make the following entry, "All as usual." Still, it would be a dreadful thing if a fundamentally sound amateur were to rely so much upon the talkers hired by the B.B.C. that he should lapse into a mere echo of them, so that he could speak of little else than



"Saw that ginger-headed girl at Victoria again."

the capitals of Europe. What Society Means, How I Swam the Channel and/or Flew the Atlantic, How Village Halls are Built, What Music is to the Ordinary Mug, and My Adventures in Morocco.

Ten thousand diaries written by ten thousand ordinary folk, even as you and I, would not bear scrutiny; they would be just records of just plain jog-trot living. Up at such and such a time. On the job all day. Home, grub, baccy, diversions (anything from stamps to dancing, bridge or new circuits) and the inevitable retirement to a feather-bed or a Nu-Health mattress.

A Radio Diary

There are no adventures for you and me, except in our imaginations, no romances except those of which it were unmanly to produce on paper. Yet I think that a diary by a conscientious radio fellow would have its bright spots, because in a way the D.X. listener really does get about, making contact, perhaps, with Europe, America and Australia. To a man like myself that has been here and there all over the globe, chug-chugging weary weeks on steamers and trains, this sitting at home in Tooting and hearing music from Australia is almost an insult. It took me eighty days to get to Australia first—and now Bill Bolton goes home to Brixton and moves a little handle round a few degrees of arc and hears the "diggers" sing and play, as one may say, on his very doorstep. Now, things like that, written into diaries, ought to make good reading, and if you can stand it I propose to show you what such diaries might be like.

Here I extract from the diary of Wm. Birch, a clerk in an insurance office.

Typical Entries

Jan. 1st.—Up at seven. Cold bath and exercises. Felt much better, but cold and tired. To office as usual. Saw that ginger-headed girl at Victoria again. Got pattern-book for wife. Argument with Jones about res.-cap.-coupling. He is old-fashioned. Him and his blessed transformers! Apple tart at Olenski's rotten to-day. Found Elsa enamelling bath at home and Bertie with toothache. Cured both of them at "pictures." Later got Moscow. Propose to overhaul aerial and earth. Try earth-screen. Now very tired. Elsa hooting about waste of gas. Better chuck it, I suppose.

January 2nd.—Up at seven or thereabout. Noticed I had left valves on all night. Battery badly down. Hope valves long-lived. (Mem.—Try invent gadget to switch off valves when I turn gas out.) No cold bath because enamel not hard. I never do exercises unless have bath. Felt warmer and less fatigued. Wilson said in train that he got Jo'burg last night. Wilson will go to the bad place when he dies. Saw a peach of condenser to-day, almost as precise as a micrometer. Must get it and smuggle it in, so that Elsa won't start off about squandermania. Thought I heard Bombay to-night, but not sure. Also J O A K (Japan); less sure. Row with maid this evening about my collars, which go laundry in sixes and come back in fives. (Mem.—Have a look at her "bloke's" neck when he calls on Sat. They would just about fit him.) Very tired.

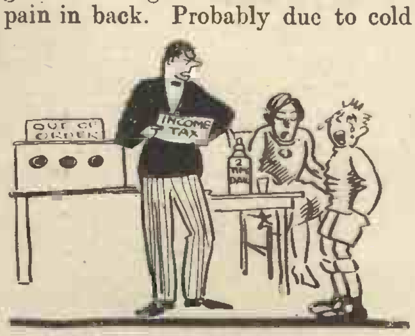
January 4th.—Missed yesterday. However, nothing to report. Valves low and Elsa had headache. Up at 7.25. No bath, no exercises. (Mem.—Believe this bath business over-rated.) Rotten day at office, but got new condenser. Also new set of coils and dinkie little cell-tester. Saw fine super-het. kit. Wonder if can get it. (Query: How smuggle into house?) Fitted new condenser; a dream. Got 2 X A D and Glasgow—I think. Interrupted by Bertie. Cut knee. Elsa terror-struck. Put on court-plaster and told him about Three Bears. Now very tired.

January 10th.—Missed several days. Very busy at office and trying super-het. kit. Rose to-day at 7.45. Think cold bath bad for heart. Also exercises. Saw ginger-head girl at Victoria again. Funny how one notices these things. Found beetle in steak-pudding at lunch; one leg apparently still alive and working in all hinges. Dead off grub. Talk on Beetles from 2 L O to-night. Saw beetle in kitchen. Got Cairo. (Mem.—Beetle sacred Egyptian emblem. Am I bewitched?) Elsa's mother called and talked for $1\frac{3}{4}$ hours about funeral of vicar. Very tired. Very tired.

The Story Ends

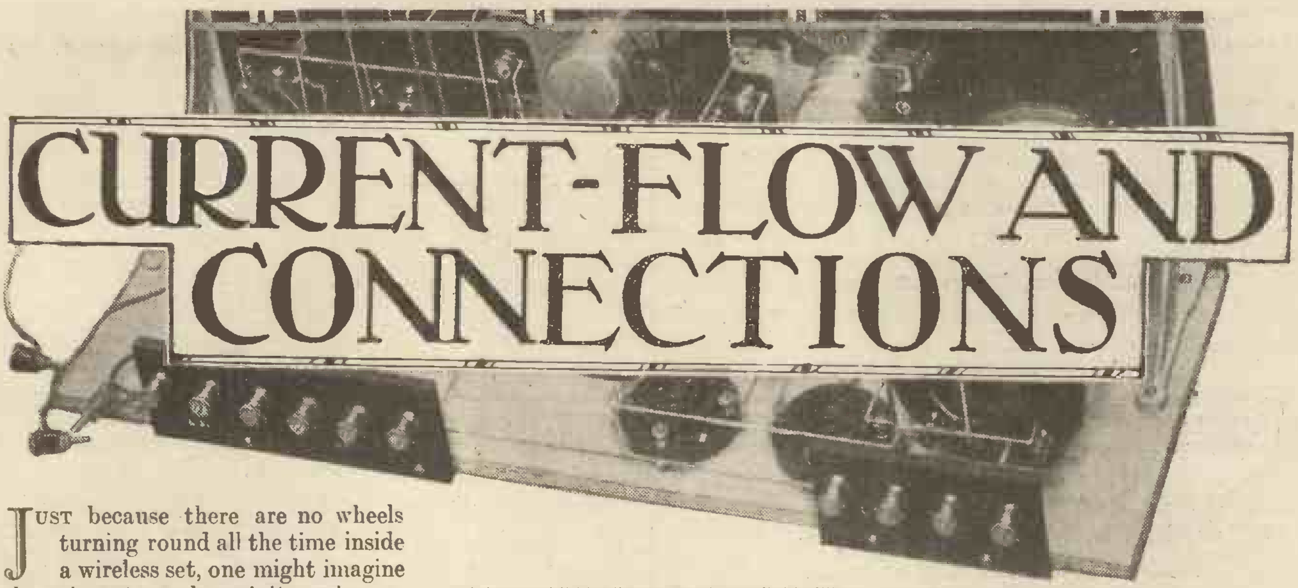
January 15th.—Missed a few days. No ink in pen. Now writing pencil. No bath. Elsa says singing gives her headache. Not sorry, as bath very cold. Found aerial sagging on to tree. Tightened it up, lost train, and missed "Ginger." Funny how one pines after familiar landmarks! Bought new loud speaker, and told Elsa I was presenting old one to Cottage Hospital. So I am; to the caretaker—for a quid. Got Madrid. Got a bit of "Tannhauser" from unknown station. (Mem.—Ask MODERN WIRELESS what station.) Pipes frozen to-day. Elsa broke last plate of best tea-service. Bertie's temperature 100 degrees. My feet cold. Very tired.

January 20th.—Bertie and Elsa got colds. I got Oslo—I think. Also pain in back. Probably due to cold



"But ain't life wonderful!"

baths. Ghastly chit from Income Tax bloke. Dirty dog! Found beetle in super-het. and Elsa found three pairs of her best silk stockings under mattress in maid's bedroom. Don't like look of new accumulator; positives got spotted fever. Tired. (*Here diary ends.*) But ain't life wonderful!



CURRENT-FLOW AND CONNECTIONS

An interesting glimpse into the work of "the wiring" of a modern receiving set.

By P. R. BIRD.

JUST because there are no wheels turning round all the time inside a wireless set, one might imagine there is not much activity going on there. But appearances are deceptive, and the work which is done outside the set by the loud speaker is not half so complex and commendable as that done faithfully and without fuss at a busy junction in the wiring.

Electro-Commotion!

The electro-commotion at any important corner connection is simply stupendous. For instance, Fig. 1 depicts a simple-looking three-valve circuit (H.F., Det., and L.F.), with split-primary H.F. transformer, and capacity-controlled reaction to its secondary. It all looks straightforward enough, but consider for a moment the "traffic problem" it presents.

When the set is switched on, what happens at one solitary connection—say, at the point indicated by the arrow? First of all, there is a stream of "traffic" passing from the L.T. battery to the filament of V_1. The size of this particular stream will vary according to the adjustment of the rheostat R_1. Going in the same direction is another filament current from the L.T. battery to V_2, the amount of this current being regulated by R_2. And in addition there is the current that flows past the same point, which we will call point "X," and up to the filament of V_3. The amplitude of this third current, also, will vary, according to the adjustment of R_3.

The Traffic Problem

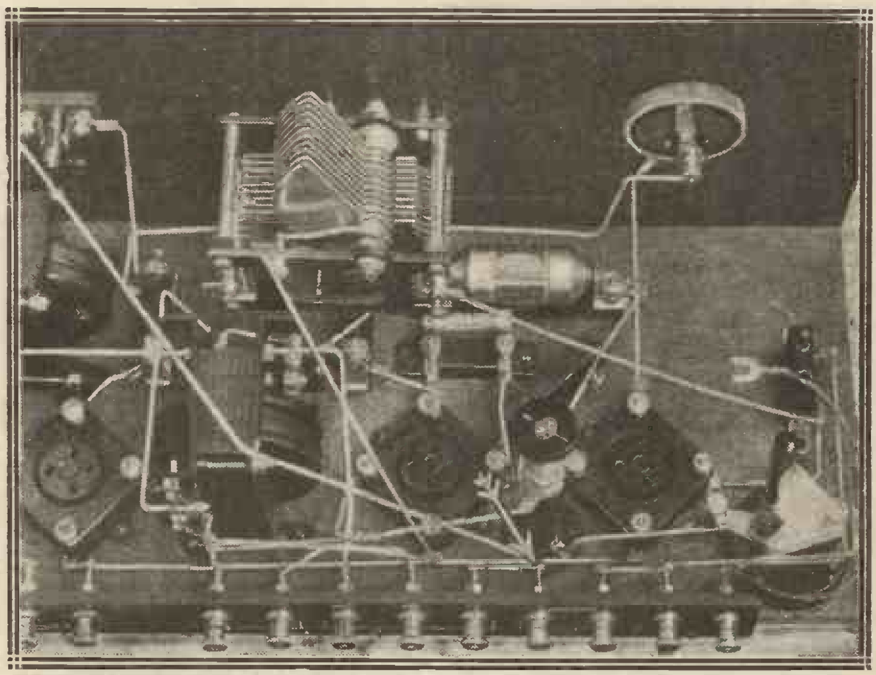
So far we have considered only the one-way traffic from the L.T. negative terminal. In addition to these three streams, what is turning round the corner along the H.T. negative lead?

Whether signals are being received or not, there is a "steady" drift of electrons from the H.T. negative terminal, past the point X, along to the filament of the first valve, across the vacuum of V_1, through half the primary of the H.F. transformer, and thence to H.T. positive.

In addition to this, another plate current is passing from H.T. negative to H.T. positive via the point X, the filament and plate of V_2, H.F. choke, and the L.F. transformer primary. And a third H.T. negative to H.T. positive stream turns off at the filament of V_3, passing to H.T. plus 2 via the plate of V_3 and the loud-speaker windings.

Variations in Volume

These three plate currents are of different amplitudes, according to the "impedance" of the valves in use. And what is more, they have to increase or decrease every time a rheostat is adjusted, or an H.T. plug is moved. In the case of V_3, too, the current can be "throttled down" by increasing the negative grid bias, and every such adjustment affects a corresponding change in the complex current-streams flowing past the hard-working point X.



The arrow shows an L.T. and H.T. "junction" of the type discussed above.

Up to the present we have considered six comparatively "steady" current streams. Any one of the six is liable to vary at any moment as adjustments of L.T., H.T. (and grid bias, too, in the case of V_3) are made. If X is a badly soldered joint we now can see the possibility of trouble with the traffic passing that point!

The Framework for Reception

But we must remember that so far no signals have been received. The set is "alive," but the currents flowing as considered above are merely the framework upon which reception is to be carried out. The real business of the set only commences when the aerial tuning condenser (A.T.C.) and the high-frequency condenser (H.F.C.) are tuned in to receive a broadcasting station.

Let us suppose that the tuning is adjusted for, say, Langenberg, but that the microphone there is "open," with nobody speaking or playing near it. What is the effect upon the set we are considering?

Our aerial-earth circuit responds to Langenberg's "carrier," and the H.F. aerial currents set up corresponding high-frequency voltage variations across A.T.C. and L_1. These variations, being applied across grid and filament of V_1, result in high-frequency variations in the plate current of V_1.

Complex Currents

At the very instant that Langenberg's positive potential goes to the grid of V_1, there is a flurry of electrons past the hard-working junction at X, and a corresponding rush of current between filament and plate of V_1, thence through the H.F. transformer primary, and back to the battery via H.T. plus 1.

The transformer primary, being coupled to L_2, varies the voltage on the grid of V_2, and this also results in a high-frequency scurry of electrons past the point X, and across V_2. The interesting point to remember is that all this happens before a word has been spoken at Langenberg's microphone! The loud speaker has so far done nothing but carry the "steady" plate current of V_3, whereas our soldered connection (X) between H.T. negative and L.T. negative has had three "steady" filament currents, three "steady" plate currents, and a couple of high-frequency currents to deal with!

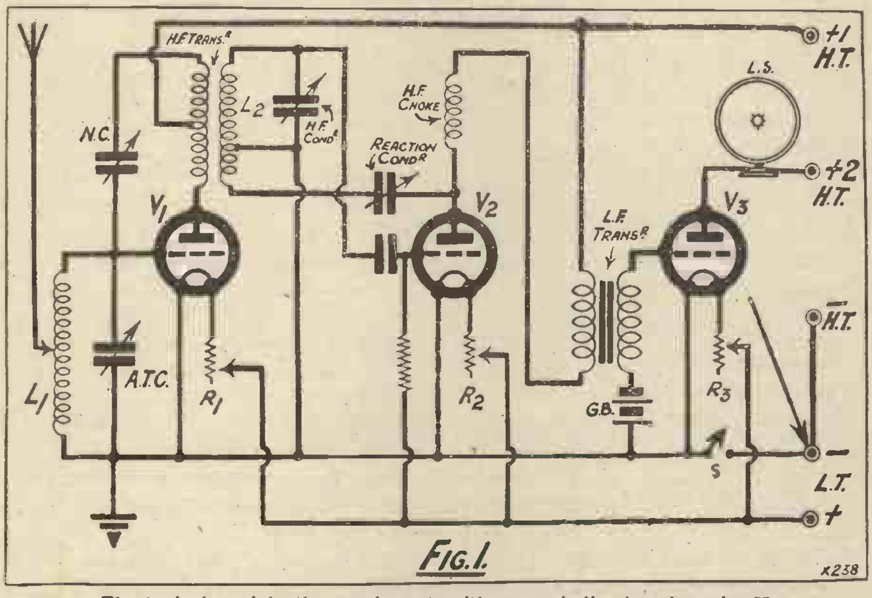


FIG. 1.

The typical straight three-valve set, with arrow indicating the point X.

We will now suppose that Langenberg's announcer says "Achtung," or something, to his microphone. What effect has that upon the current congestion at our hard-working corner X, before the loud speaker can echo the word?

Voltage Variations

The speech-modulation of the high-frequency currents will be attended to by the grid-leak and detector of V_2, and will result in a low-frequency modulation of the plate current of V_2. The "steady" plate current will flow as before across the valve, but there will be a little ripple on its surface, representing the effect of the voice.

The secondary of the low-frequency transformer, which has not paid much attention to the "steady" current, is so impressed by the voice-voltage variations of the ripple that it repeats them in magnified form to the grid and filament of V_3. And, again, our point X bears the brunt of a change in current.

As the voltage on the grid of V_3 varies, so its own particular current-flow (past X, and through the valve and L.S. to H.T.2) rises and falls in volume.

The Last Link

It is this change, and this only, that actually works the loud speaker. But as we have seen, the loud-speaker current is only the last of a whole series of currents, all essential to reception, all mixing and mingling, and all liable to sudden fluctuations! If we bear in mind the complex commotion that goes on at only one point in the wiring we shall never again imagine that a half-soldered joint is "good enough," or that there is little or no activity inside a wireless set.

RADIO REMINDERS

It is not necessary to tin *all* the surfaces of the soldering-iron; one tinned surface is quite sufficient.

* * *

To convert frequency into wavelength, or vice versa, divide the number of kilocycles or the number of metres into 300,000.

* * *

When an H.F. valve has a very high impedance in its plate circuit it can often be run with success at a filament voltage much lower than the normal.

* * *

In a general sense the higher the amplification of an H.F. valve, the better the selectivity of the set.

* * *

When a valve gets "soft," it is passing far too much anode current, and consequently it is not economical to continue to use such a valve.

* * *

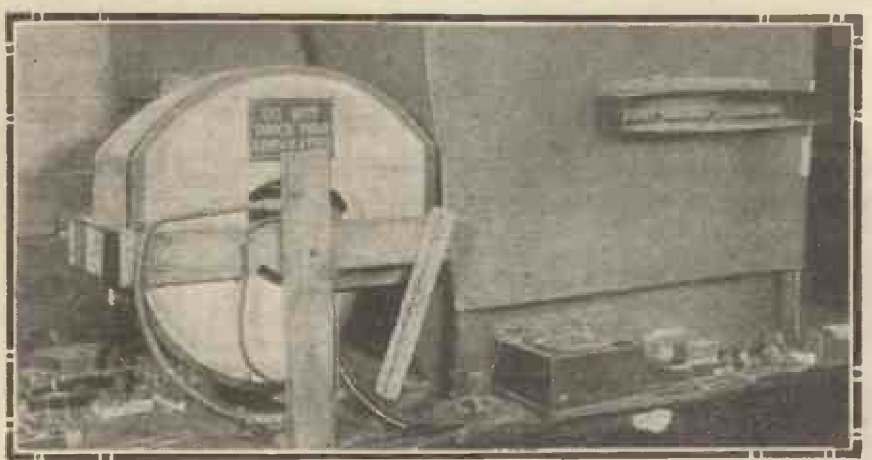
"Swinging coil" reaction gives very good results on short waves, provided that a really good coil-holder is used.

* * *

For short-wave work the aerial should be taut, or its swinging may effect reception.

* * *

The human ear is very insensitive to variations in the *volume* of sound, and is frequently unable to detect a difference even of twenty-five per cent.

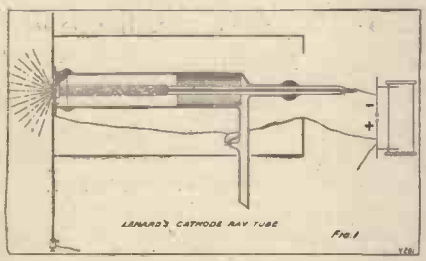


SHOOTING ELECTRONS THROUGH GLASS

The wonders of the latest thermionic "tube" are here described by

Dr. J. H. ROBERTS, F.Inst.P.

WHAT would happen if you increased the voltage between the filament and plate of a wireless valve up to hundreds of thousands of volts? It is obvious that the electrons from the filament



would be shot towards the anode with greater and greater velocities as the anode potential was increased. A well-known American scientist, Dr. W. D. Coolidge, whose name is principally associated with the Coolidge X-Ray tube, has, in fact, succeeded in doing this.

Of course, if you applied 100,000 volts to an ordinary wireless valve, a spark would jump across the input leads, but by means of a special tube, about three feet in length, these tremendously high voltages can be properly applied.

The New Tube

The Coolidge X-Ray tube consists essentially of a glass bulb about ten inches in diameter, with two glass tubes projecting at opposite points. A heated filament is introduced as a source of electrons, and opposite to the filament and in close proximity with it is the anode or "target," as it is sometimes called. When a high voltage is applied between the cathode and anode, electrons are driven at very high speed against the anode and, in hitting the latter and being suddenly arrested, they give rise to ethereal vibrations, known more particularly in this case as X-Rays.

Now suppose the anode be rearranged as in the accompanying figure, in which it consists of a long metal sleeve terminating in a nickel "window." In this case the electrons, or most of them, will be shot down the metal tube and will hit the nickel window. This window forms part of the envelope of the tube, having atmospheric air on one side of it, and the vacuum on the other. If the window is sufficiently thin, and the electrons hit it with sufficiently high velocity, some of the electrons will shoot clean through the window and out into the air.

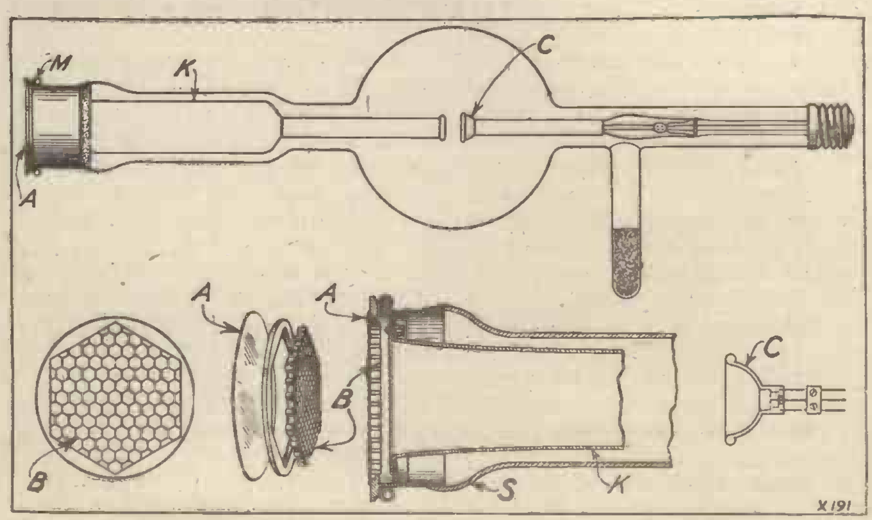
An arrangement of this kind was used many years ago by Lenard, a German physicist, who used a tiny aluminium window and did, in fact, succeed in getting a small quantity of electron radiation out into the air.

Thin Metal Window

No doubt you will be wondering how it is that the extremely thin sheet of metal (which in Coolidge's cathode ray tube is only 5/10,000ths of an inch, that is 1/2,000ths of an inch in thickness) can support the atmospheric pressure on one side without bursting inwards. The reason is because the window is made of extremely small area, as in the Lenard tube, or it is supported upon a honeycomb grid as in the Coolidge tube, in which case it acts as a collection of tiny windows, each of which, although of such very thin metal sheet, is able to support its appropriate part of the force due to the atmosphere outside. Incidentally, I may remark that one of the manipulative difficulties in this experiment is to obtain the metal sheet sufficiently thin without any minute holes in it. Of course, the tiniest pin-hole would make it entirely impossible to obtain the exceedingly high vacuum which is necessary inside the tube.

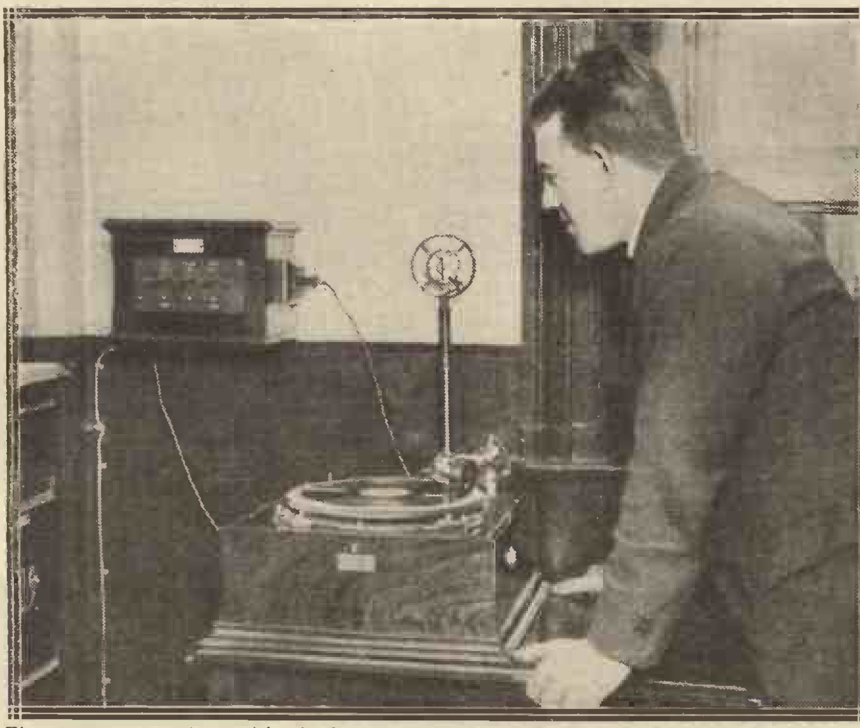
150,000 Miles per Second

It may seem also surprising that the electrons should be able to shoot



The new Coolidge tube. The various sections are denoted by the following: A, the nickel window; B, the honeycomb screen and support; K is the copper anode; C, the cathode; S, the glass tube; M, the anode connecting terminal ring.

through the metal window, but it must be remembered that the latter consists of a collection of molecules or atoms, the latter being formed, principally, of tiny electronic planetary systems, and therefore an object of corresponding minuteness, such as the electron, may, under proper conditions, find its way through. In some of Coolidge's experiments the electrons are calculated to reach a velocity of 150,000 miles per second, or a value nearly equal to that of the velocity of light. The air cannot get into the tube because the oxygen and nitrogen atoms or molecules are of a similar size to those of the metal and furthermore they have not the necessary velocity.



The remote-control panel in the Lambeth hospital, recently equipped with a magnificent radio installation. The transmission of gramophone records as well as broadcast programmes can also be carried out.

The nickel window is secured to the glass in a special way. It is first of all soldered to a ring of "invar," which is an alloy of nickel and steel. This "invar" alloy has the property that it expands and contracts with changes in temperature by almost exactly the same amount as the glass to which it is sealed and consequently a perfectly vacuum-tight joint may be made between invar and glass.

Honeycomb Support

The honeycomb grid behind the window, which supports the outside air pressure (amounting in one of the latest tubes to a force of a hundred pounds weight), is made of molybdenum. The copper tube which forms the anode is to protect the glass from the electron stream, as otherwise the intense bombardment of the glass by the electrons moving with such a high velocity would soon result in the glass being punctured.

Effects of the Rays

When the tube is switched on in a dark room, a purplish glow is seen for a distance of about 2 ft. from the little window. This glow is due to the bombardment of the gas molecules of the atmosphere by the electrons. Some very curious effects have been observed when subjecting various substances to this intense electronic bombardment. A crystal of calcite glows with a bright orange light and even after the bombardment ceases the crystal continues to glow as if red-hot, the glow continuing for several hours. It can be made to show bluish scintillations by scratching it with a sharp metal point. Amber, resin, and compounds of barium, potassium and calcium all show these curious scintillations. It is thought that this scintillating or sparking effect is due to electrons driven right into the interior of the substance, and therefore producing a potential-gradient between the interior and the surface, the scratch with a sharp point causing miniature discharge flashes.

Hard rubber, and a mixture of resin and carbauba wax, can be permanently electrified by exposure to the electron stream, producing what has sometimes been known as an "electret" (analogous to a permanent magnet). Glass which is exposed even for a few minutes to the rays becomes permanently of lavender colour.

Acetylene gas exposed for a few seconds is converted to a yellowish brown powder, which at once falls to the bottom of the vessel in which the acetylene gas was contained.

Some curious effects are also obtained upon living tissue. The ear of a living rabbit was exposed for $\frac{1}{10}$th of a second to the rays, the actual current in the tube being one milliampere (at 350,000 volts). The skin became darkened as though sunburnt, and a sore appeared a few days afterwards, but at the end of two weeks the sore was healed and a profuse growth of snow-white hair appeared, which eventually became much longer than the original grey hair.

It had been suggested that this tube might be used for offensive purposes in warfare, but that seems hardly likely in view of the fact that even with the highest voltages practically possible, the range of the electrons outside the tube would not be more than a few feet.

Equal to a Ton of Radium

It is interesting to note that the electron emission coming through the nickel window in this tube is about equal to the beta rays from a *ton* of radium. It is estimated that a ton of radium would be worth about £20,000,000,000, but the fact is that there is considerably less than one pound of radium available in the world.

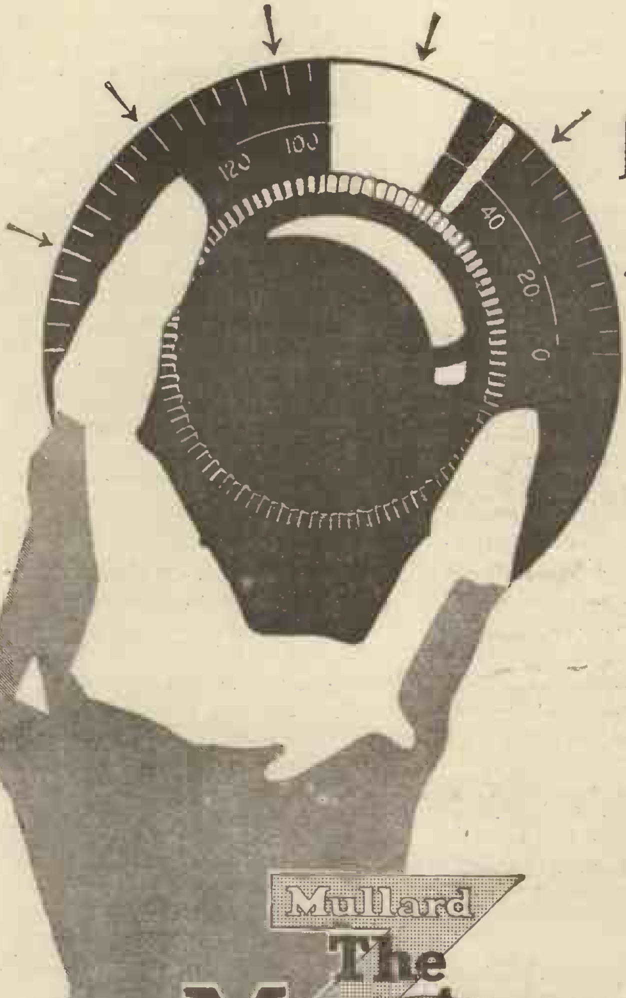
A NOVEL CONDENSER

Some two or three years ago a variable condenser was introduced in America in which mercury was used as one of the electrodes, the other electrode being a semi-circle of metal which was coated with an extremely thin film of insulator such as shellac varnish or celluloid varnish. The mercury being, of course, at the lower part of the container, the vane was rotated so that it dipped more and more into the mercury, thus increasing the capacity of the condenser.

Now however, in the German Journal "Radio" an advertisement of a "Quicksilver condenser" has appeared which operates on precisely the same principle. One of the principle advantages is its small size for a given capacity.

Station after Station

As easy as setting the hands of a clock



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OPERATING THE VIKING IV

Some practical hints on handling for best results.

By G. P. KENDALL, B.Sc.

THE Viking Four is not one of those receivers with which it is essential to use certain very definite types of valves in order to obtain correct stabilisation and so on, and it is, indeed, a good deal less fastidious in this respect than the majority of neutrodyne receivers, but even so there must naturally be a little care devoted to the choice of suitable types if one wishes to obtain the maximum results.

Valve Data

So far as long-distance results are concerned, of course, the most important valve is that in the H.F. stage, and what we require here is one with an impedance of between 13,000 and 30,000 ohms, with as high an amplification factor as we can obtain within those limits, which will probably be found to be somewhere between fifteen and, perhaps, twenty-five. Here are a few examples in the 6-volt range: P.M.5X, S.S.6075 H.F., Cossor 610 H.F., D.E.L.610. Equivalent types can, of course, be chosen in most makes from the various other classes of filament rating.

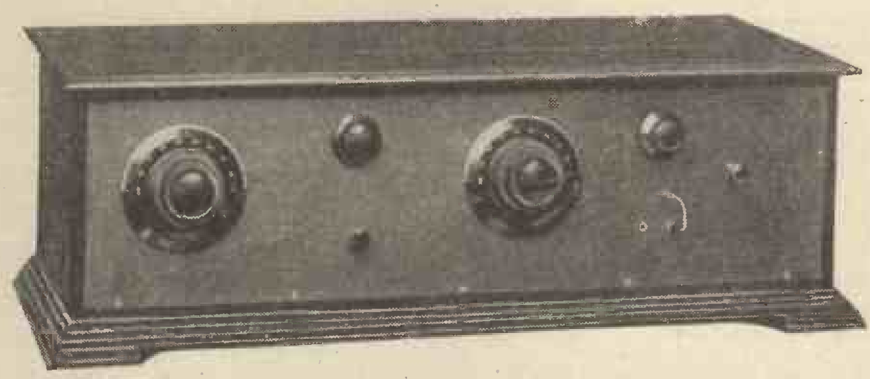
In the detector stage a very similar type of valve is suitable and is to be preferred from the point of view of obtaining the smoothest reaction control for the reception of distant stations. For general purposes such a valve is probably to be preferred here, but on a fairly strong station somewhat louder signals can be obtained by using a valve of the R.C. type in this stage; but since it is much more difficult with these to obtain smooth reaction control it is not to be recommended for the reception of really weak transmissions, where a fine setting of reaction is essential.

L.F. Valves

In the first L.F. stage a medium-size valve is desirable, remembering that if one of too low an impedance is used the anode current will be so large as to run considerable risk of saturation of the core of the L.F. transformer, with a corresponding sacrifice of faithfulness of reproduction. A medium-size L.F. valve is suitable here, while if it is not intended to handle extremely powerful signals, the usual practice is to use a valve of the H.F. type, with an impedance of perhaps 15,000 to 20,000 ohms, with a suitable adjustment of grid bias of about 3 or 4½ volts, according to the H.T. used.

When such valves are used, of course, one must take a little care not to try and make the set handle too enormous a volume on the local station, lest this valve be overloaded and distortion result.

In the last stage, obviously, a good power or, preferably, a super-power valve is required to conform to modern standards of faithful reproduction, unless one is going to be content with a very modest output such as can be handled by a smaller L.F. type of valve. In the super-power range the following are a few suitable examples: P.M.256, Stentor 6, S.S.625 S.P., D.E.5A. etc.



For a powerful long-distance set the Viking IV has an unusually neat and pleasing appearance.

The high-tension voltages for the Viking Four should be the standard ones for a set of this general type. On H.T. + 1, for example, which supplies the H.F. valve, about 100 volts is desirable, since when fairly high voltage is used here, greater amplification is obtainable, and in a properly screened and neutralised set there should be no difficulty to obtain stability.

H.T. + 2 feeds the detector valve, and here the usual procedure of adjusting the voltage to give the smoothest control of reaction should be followed. Remember, however, that there is a fairly high value of anode resistance in series with this lead, and therefore the voltage will probably need to be fairly high, say, between 80 and 100 volts.

The terminal H.T. + 3 provides the feed for both the L.F. valves, and here the usual practice of using the full voltage available up to about 140 volts for normal valves should be followed. Remember, that the higher the voltage employed here the more perfectly the set will be able to handle loud signals, although, of course, it should be remembered not to use such an excessive voltage that it will shorten the life of the valve.

Grid Bias

Turning now to the question of grid bias, that applied to the two low-frequency valves will, of course, be adjusted according to the instructions of the makers of the valves chosen, and the necessary guidance will be found either upon the valve box or upon the slip found with the majority of valves. Remember, however, that the higher the value of grid bias chosen the lower will be the drain upon our high-tension battery, but, of course, this must not be carried too far or reproduction will suffer in quality as a result of incorrect adjustment. While dealing with the question of grid bias, it may be as well to explain the correct use of the alternative rectification scheme, by means of the plug and socket arrangement on the front of the panel.

Smoother Control

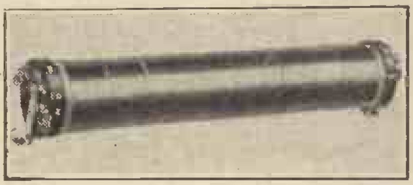
It has already been mentioned that when this plug is inserted in the right-hand socket looking from the front, the grid-condenser method of rectification is obtained, and this is desirable in most cases for the reception of weak signals, chiefly because it enables a much smoother control of reaction to be obtained with the majority of valves.

(*Continued on page* 110.)

In Our Test Room

Three Marconiphone Items

So far, the interests of the enthusiast desiring to operate a receiver from mains of the D.C. variety appear to have been somewhat neglected but there are problems in regard to the operation of valve filaments from D.C. mains which are not encountered in A.C. work. The amateur having A.C. mains has several alternatives offered him. He can step-down his voltage by means of transformers and rectify the resultant current and run his valve filaments in the usual way, subsequent, of course, to smoothing, or he can, more simply, use those valves whose filaments can be operated directly with "raw" A.C. current.



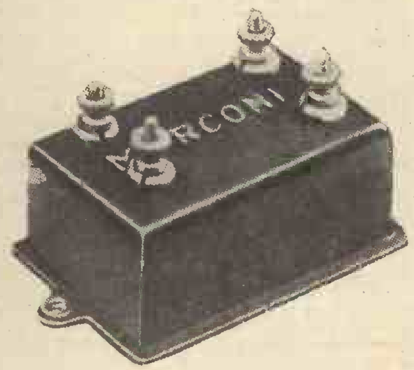
The Marconiphone Power Drive Resistance Unit.

No quite such simple scheme is possible with D.C., and here the only practical system appears to be to operate a number of ·1 valves in series. For such a purpose the Marconiphone people have an excellent choke. Having an inductance of twelve henries this will pass ·15 amperes without the slightest distress. Its D.C. resistance is 120 ohms, and this can be usefully employed in stepping down the voltage to the correct figure. The price of the Marconiphone filament choke is 22s. 6d. It is soundly designed and robustly constructed. We have had two of these Marconiphone filament chokes in use, and they provided adequate smoothing even on rather "noisy" mains.

Another useful device is the Marconiphone "Power Drive Resistance Unit." This is a tapped resistance element which, connected across the mains, serves several useful purposes. It will reduce the current sufficiently to operate ·1-ampere valves in series and break down the voltage of any mains between 100 and 250 volts to tappings at 60 and 100 to 120 volts for H.T. supply to the detector and other valves. The tubular winding allows large cooling surfaces and prevents overheating. The price of this resistance unit is 18s. 6d.

The Marconiphone people have also lately brought forward two new resistance-capacity units. These are very neat little devices and embody special leaks and condensers tested to 1,000 volts. There are two types: type A, for valves of medium impedance, such as the D.E.5B., D.E.L.610, etc., which retails at 8s.; and type B, which is for use with high-mu valves, such as the D.E.H.610, D.E.H.410, D.E.H.210, and so on, which sells at 7s. 3d. Recently though these units were received, we have already had one in service in a receiver in which its performance has been well up to the standard expected of a component due to a firm of such high standing.

The filament choke referred to in the first column.



A Marconiphone R.C.C. Unit.

Some Lissen Productions

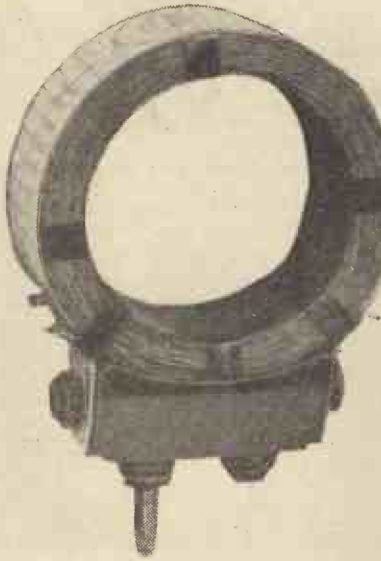
One of the most notable features of Lissen headphones are their remarkable lightness. They weigh but an ounce or two, and have universal adjustments to the earpieces, which enable them to be comfortably placed into position and so locked by the simple adjustments of two milled screws. They are provided with long leads of a tough and pliable nature, which do not tend to twist.

Although they are small and light, they are distinctly sensitive, and respond with an excellent tone to either weak or strong signals. No doubt they owe, to a great extent, their excellent degree of audibility to the fact that each earpiece cap is provided with four large holes, enabling the sound to project from practically the entire surfaces of the diaphragms.

These Lissen headphones are well made, and appear to us to be remarkably cheap at 8s. 6d.

We believe that the Lissen two-way coil holder is the first component of this nature to embody the metal-to-metal friction drive which is a feature of so many variables and slow-motion

dials, and it gives the Lissen two-way coil holder an attractively smooth and positive action. Another novel feature of this Lissen product is that



One of the new centre-tapped coils made by Messrs. Igranic, Ltd.

the control shaft and knob can, in a very simple manner, be reversed and the moving portion of the holder made to operate in the reverse direction. Further, the need for flexible connections is obviated by the provision of four fixed terminals. This Lissen coil holder is, indeed, an excellent production.

Quite recently we had a large number of Lissen grid leaks on test. These little items proved to have resistances abnormally close to their stated ratings. In fact, quite a number gave dead "megger" readings. The resistance of the grid leak was stated to be one or two megohms, as the case may be, and the megger actually gave the "one" or "two" to a "hair's breadth." The greatest error noted did not exceed five or six per cent. Such precision is extraordinary, more especially in view of the low retail prices of these Lissen grid leaks.

Igranic Tapped Coils

Better late than never, is evidently the motto of the Igranic Co., who have recently produced a comprehensive range of tapped coils. There are five types, each having two tappings more or less corresponding with the arbitrarily accepted standards for such devices. Similarly to the ordinary Igranic coils, each of these new tapped coils is wound in three distinct sections in order to reduce self-capacity to the lowest possible minimum.

On the one side of the base is a green socket and on the other a red socket, and into these standard wander plugs can be inserted in order to make connections to the tapping points. It is a very sound scheme, and in some respects is distinctly superior to the more usual terminal method. They have low self-capacities and operated well in all the positions in which such coils normally figure.

The arrival of these new coils will be good news to Igranic adherents, more especially those having older types of receivers who wish to replace existing aerial coils for tapped coils in order to obtain that extra selectivity that modern radio conditions necessitate.

New Becol Component

The British Ebonite Co., Ltd., have produced a refreshing variation from the standard six-pin coil former and base. The most noteworthy feature is the ease with which the former can be slipped into the base. The former comprises a tube of ebonite of the well-known Becol pattern, and at the one end between the ribs are fixed six metal plates. The base has a large circular projection over which the former slides, and the fixed metal plates engage six spring contacts arranged radially round the base.

A slot device ensures that the former goes on in the right manner, and two white indicating marks ensure that there is no delay in doing this. It is certainly an excellent scheme, and one that should ensure the component's popularity. The contacts are positive and self-cleaning. Of the low loss and other advantages of the former itself little need be said, for these will be well known to all constructors. Four contact formers and bases of a similar type are also available at the same price of 10s. 6d. each. Also formers for fitting inside these of 2¼ in. length, and suitable for reaction and other such windings, are obtainable at the low price of 6d.

Dubilier Fixed Resistors

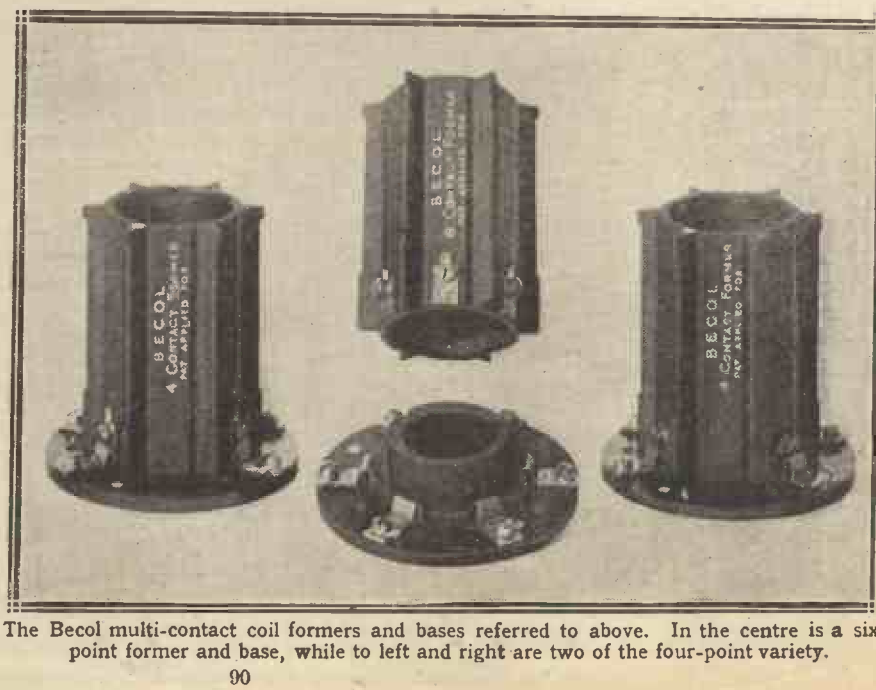
Messrs. Dubilier's have produced a very comprehensive range of fixed resistors in which are values catering for every conceivable valve requirement. They are of the size and appearance of the average type of grid leak. Therefore, very conveniently they can be carried in the Dubilier Dumetohm grid-leak holder, the whole making a

One of the Dubilier Fixed Resistors.

very neat baseboard assembly. As expected, the sample tested by us proved to be accurately rated.

They also handled a current up to a quarter of an ampere without the slightest heating. There is nothing at all against the use of fixed resistors with modern valves and modern receivers, while to compensate for L.T. supply variations, one can always employ a master rheostat, a component which can also be used as an "on-and-off" switch. The facility with which the Dubilier resistors can be used and their compactness are attractive features which will appeal to the practical constructor.

(Continued on page 104)



The Becol multi-contact coil formers and bases referred to above. In the centre is a six-point former and base, while to left and right are two of the four-point variety.

A NOVEL GRID-BIAS SCHEME

An illuminating little article on grid connections.

By D. GLOVER.

It is quite possible to use a small section of the H.T. battery for providing grid bias, but this is only practical where it is tapped at each $1\frac{1}{2}$ volts from its minus terminal for at least six or so cells. Instead of joining the L.T. minus to the H.T. minus terminal the L.T. minus is taken to one of the plus points $7\frac{1}{2}$, 9, or $10\frac{1}{2}$ volts away from the negative cell of the H.T. battery according to how much grid bias is needed. The grid-bias wander plug is then tapped into any one of the sockets between the negative of the H.T. battery and that point to which the L.T. negative is connected. This scheme is shown theoretically in Fig. 1.

Ingenious Method

A rather more ingenious method of deriving grid bias from the H.T. battery is shown in Fig. 2. Here a high-resistance potentiometer is connected in series in the anode circuit. By varying the slider of the potentiometer, a very close adjustment of grid bias potential can be obtained. At first sight it might appear as though a positive bias would be obtained, but this is not, of course, the case. It is desired to make the grid negative in respect to the filament. How this is obtained can be explained in a very simple manner by redrawing the circuit as in Fig. 2A.

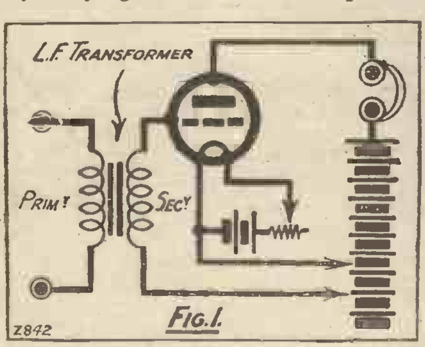


FIG. 1.

Here is shown the H.T. battery connected in series with two resistances. From the positive terminal it goes to resistance X, which represents the resistance of the low-frequency choke and of the valve between the plate and the filament, and then through Y, which represents the potentiometer, and so back to the negative terminal. You will see that point A is to where the filament is taken, and point B represents the slider of the potentiometer, which is joined to the grid of the valve through the secondary of the low-frequency transformer.

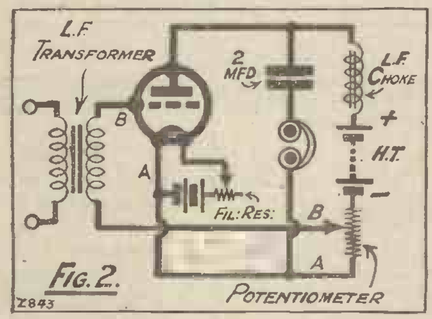


FIG. 2.

Now you will be able clearly to see that point B, which represents in effect the grid, must be negative in respect of A, which represents the filament, and as the slider of the potentiometer is taken farther and farther away from point A, it must become more and more negative until it reaches the maximum possible point. The amount of grid bias potential which can be obtained by this means will depend upon quite a number of things, as you will see. First of all the voltage of the H.T. battery, then the resistance of the low-frequency choke and of the valve, and then, finally, the resistance of the potentiometer. The simple formula is:

$$Gv = V\frac{Y}{X + Y}$$

Gv being grid volts, V equalling the voltage of the H.T. battery, X the D.C. resistance of the low-frequency choke and of the valve, and Y the resistance of the potentiometer.

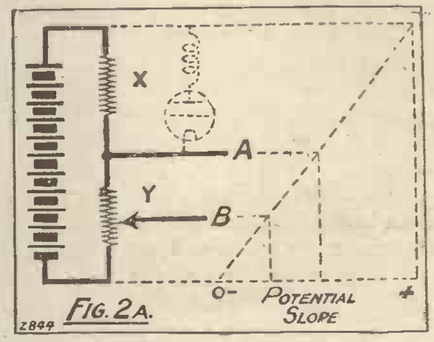
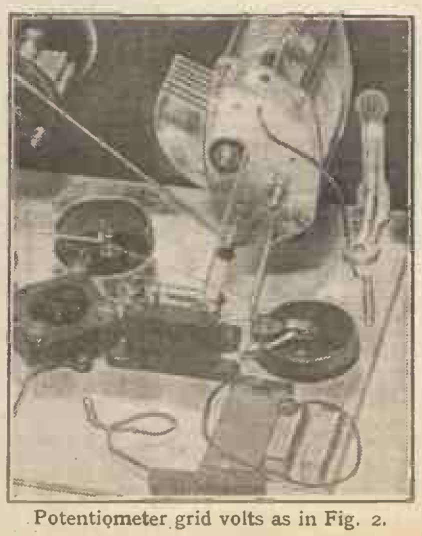


FIG. 2A.

By-Passing Necessary

If you required a grid bias of, say, 16 or so volts, it would be necessary in the case of a valve and low-frequency choke having a resistance of 5,000 ohms to employ a potentiometer of 1,000 ohms resistance. You will see that you are not obtaining grid bias in this way without sacrificing something. Placing the potentiometer in the anode circuit has the effect of dropping the effective anode voltage obtainable with a given H.T. battery. Correspondingly, therefore, it is necessary to raise the voltage of the H.T. battery. If the by-passed loud speaker or telephones is not introduced, it will be necessary to by-pass the potentiometer with a large fixed condenser of the order of 2 mfd.



Potentiometer grid volts as in Fig. 2.

RADIO NOTES AND NEWS OF THE MONTH

A feature in which our Contributor brings to your notice some of the more interesting and important Radio news items.

Conducted by "G. B."

The Time Factor

THE "Manchester Guardian" recently pointed out that many of the Continental stations, owing to the difference in time, commence the evening programme much earlier than our stations. Although the strongest of them does not consistently reach its highest volume till about two or three hours after sunset, some often come in with surprising strength quite early in the evening.

On the broadcast band, Langenberg, Frankfurt, and Hamburg often have sufficient strength to give loud-speaker signals for a quiet room from only two valves as early as six o'clock. These distant stations, however, cannot be held long at that strength so early, owing to fading.

The long waves are more reliable. Fading, although present with some stations, is never quite as bad as with shorter-wave stations. The long wave-band almost invariably provides the distant-station searcher with a richer haul of good stations, although there are less of them to pick-up.

Radio Criticism and Plays

The B.B.C. may be rather shy of broadcasting controversial matter, but one cannot say that there is any lack of controversy about the B.B.C. itself.

That is very nearly paradoxical—but the fact is the B.B.C. is like a red rag to a bull, to many people who have the idea that the B.B.C. is inimical to vested interests.

The latest wrangle turns on the question: Should plays be criticised by wireless?

James Agate, the B.B.C.'s dramatic critic, is well known to listeners, and his chats about plays, although inclined to be a little pedantic, are often worth listening to. But many theatre managers don't like his theatre talks. In fact, they hate them!

"Not Worried!"

The explanation for this is that the majority of theatre managers regard broadcasting as a serious rival, and, as one manager pointed out (according to Hannen Swaffer in the "Daily Express"), managers invite newspaper critics to their shows, but they don't invite the B.B.C., and consequently they don't want the B.B.C.'s criticisms. There is nothing illogical about this — but although in an argument the managers might win, I don't suppose the B.B.C. will discontinue broadcasting dramatic criticisms. The theatre managers have their chance, however; they can criticise the B.B.C. in "Curtain Raiser" chats—or print their views on theatre programmes. I don't suppose the B.B.C. would mind!

A "Peace" Station?

The Swiss Marconi Co.'s scheme for the erection of a 50-kw. station for the use of the League of Nations

(*Continued on page* 95.)

RADIO NOTES AND NEWS OF THE MONTH

—continued from page 94

is one which, if put into practice, may play a most important part in increasing the friendship of nations.

The station, if built, will be used by the League for broadcasting information and propaganda. It would, in reality, be a "Peace Station"—and, just as some of the Russian stations to-day broadcast Bolshevik propaganda, so would the League's station make it its business to disseminate harmony, good will, and friendly understanding between nations. There's room for a station like this, and it should play a most important rôle in the affairs of European politics.

The World's Broadcasters

The latest official figures given by the Commerce Department at Washington shows that the United States have 685 broadcasting stations, or more than all the rest of the world combined. It is also declared that the most powerful stations to be operated are in America, with Russia and Sweden next.

The total of the world's stations, exclusive of the United States, are given as 431, of which Europe has 196, North America (outside the U.S.) 128, South America 52, Asia 18, Oceania 28, and Africa 9. The three most powerful stations, which are able to operate on 50,000 watts, are W E A F, at Bellmore, New York, owned by the Radio Corporation of America; the General Electric Company's station W G Y, at Schenectady; and the Westinghouse station K D K A, at Pittsburg.

The Russian Government operates two powerful stations at Moscow, one on 40,000 watts, the other on 20,000 watts power. There is also the privately controlled station at Leningrad at 10,000 watts. Sweden's high-powered station at Motala operates on 40,000 watts. Daventry, with its 16,000 watts, is the most popular European station.

Motala

The "star" station of the long-wave group is generally Motala, the 30-kilowatt station in Sweden, on 1,320 metres, although at times it is closely rivalled by Kalundborg, the Danish station of seven kilowatts, on 1,150 metres. A comparison of the two stations in Manchester, from which they are nearly equal distance, seems to prove that power overcomes fading to a certain extent, for the 30-kilowatt station is never subject to fading to the extent that the smaller powered one is.

Telemotion

A new device to be used in conjunction with wireless broadcasting has recently been patented.

It is called "Telemotion," and if the claims made for it are substantiated it will be possible for a listener sitting at home to see, pictured before him, the incidents of a horse race or even of a football match.

"Telemotion" is an elaboration of electrical timing of any movement. The invention will record, for example, the running of greyhounds on a race track. As the dogs race round the course their progress will be "written" by wireless signals, which can be broadcast, so that any person having the necessary apparatus at home can see the reproduction of those signals on a miniature track or on a screen, and so watch the actual race run before him.

No Photo-Electric Cells

It is the same with horse racing, or with any sporting event in which the movements of the figures are "organised," as it were, and proceed on defined lines.

"We can transmit practically any moving objects," says Dr. J. H. T. Roberts, who is also Scientific Adviser to this journal. "The reproducing arrangement may be connected to a cinema projector, and a race or other sporting event (for instance, the Boat-race) shown on the screen to the audience as the event is actually taking place.

"One important point about this new invention is that it depends entirely on established electro-magnetic principles. 'Telemotion' does not in any way employ photo-electric cells or the phenomenon of persistence of vision, which have hitherto proved such enormous difficulties in the development of television."

The invention has also a number of other commercial possibilities.

Poland's New Station

Has any reader heard Poland's new 10-kilowatt station at Katowitze, which came on the air a week or two ago?

This station is transmitting on a wave-length of 422 metres.

A Washington Squabble

I hear that the Washington Conference was not all plain sailing from the amateur point of view, and that only after long and often heated arguments and pleadings by K. B. Warner (Secretary of the Amateur Radio Relay League) did the amateur get his interests decently recognised.

The trouble was that delegates from Europe were opposed to the amateur being "recognised," because of the system of Government control existing in Europe.

The American amateurs, however, stood up for amateur interests and the fight was eventually won. Agreement was arrived at by the delegates, and it was settled that the amateur may "carry on" as follows.

Amateur Wave-Bands

Amateurs will be allowed to operate on wave-bands between 150 metres and 175 metres and 75 metres to 85 metres, sharing these with mobile and point-to-point commercial users of radio. The new regulations are not expected to become effective until 1929, and amateurs hope that the interval may be occupied with re-adjustments.

Another band of from 20·8 metres to 21·4 metres, which represents 400 kilocycles in the international day band, is available, and is considered ample for all amateur work for some years. Finally, there are two wide experimental bands at 10 metres and 5 metres which are not regarded to-day as of any commercial value.

To Move or Not to Move?

"We intend to move 2 L O from Oxford Street as soon as a suitable site in the country north of London can be found." (A London "Daily" quoting a B.B.C. official.)

"That the 2 L O station is to be moved out of London at an early date was denied last night." (Another "Daily" published next day.)

A little confusing—but the fact is that 2 L O is not to move—at least, not for some considerable time. If the Regional Scheme does not "come off," it is likely 2 L O will still retain its present site for some years to come.

2 L V and 2 L W

Mr. Robert Tingey, M.I.R.E., tells me that he is still receiving letters and postcards intended for the above stations, but that these call-signs no longer belong to him. Will interested readers therefore cancel Mr. Tingey's name from their lists of amateur call-signs.

A Reliable Short Wave Transmitter

A "Never-Fail" transmitter providing easy exchange from one waveband to another.

By C. P. ALLINSON, A.M.I.R.E.

In the course of my transmitting work I have found that one of the great drawbacks to most transmitting circuits is the time taken in changing from one wave-length to another and the number of adjustments which have to be made in doing so. So many of the more usual transmitting circuits require at least one or two taps to be taken from coils, or else need three or more coils to be

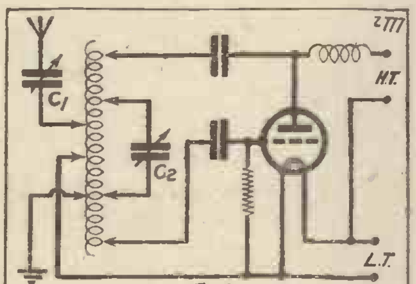


FIG.1.

interchanged, and the process of going from one wave-band to another is generally attended by a considerable expenditure of time.

Take, for instance, the circuit shown in Fig. 1, which is a conventional direct-coupled Hartley transmitter. It will be seen that seven tappings have to be taken from this coil, and even when working on the short waves, where the shunt condenser C_2 is left out, there are still five tappings which have to be adjusted in any wave-length shift.

The Fundamental Circuit

In a case where the shunt condenser is needed we further have the adjustment of two variable condensers which has to be carried out, while it is also desirable to use different coils for the 150-metre transmission as compared with 46-metre transmission.

The fundamental Hartley Circuit is shown in Fig. 2, and will seem to consist of a coil tuned by a variable condenser and is connected between grid and plate of the transmitting valve while the L.T. return is tapped on to the coil at some convenient point. A consideration of this circuit will show that a variation of it can quite easily be worked out by means of which the tapping on the coil itself is eliminated so that the coil may be made interchangeable with the greatest of ease.

Final Arrangement

The circuit as finally evolved is shown in Fig. 3. The oscillatory circuit consists of a coil L_1, tuned by a variable condenser C_2, which is connected via a stopping condenser between plate and grid. The stopping condenser C_3 may be made variable, as it may assist in obtaining a certain amount of control. The filament tap is obtained by means of a balancing condenser, shown at C_4. This consists of two sets of fixed plates and one set of movable plates so mounted that as the capacity of one portion is increased that of the other is decreased. By rotating the spindle of this balancing condenser it is therefore possible to alter the position of the filament tap with respect to the oscillatory circuit.

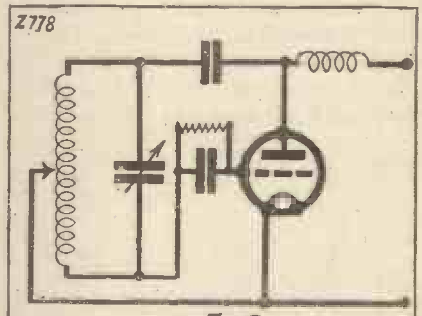


FIG. 2

The capacity of this condenser which exists between the filament tap and the grid can be used to take the place of the usual grid condenser, and a grid leak R_2 is connected as

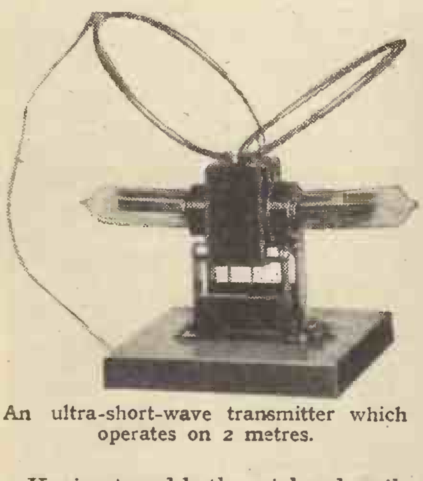
There are always plenty of amateur stations to be heard on 45 metres.

shown, between the grid and L.T., a small H.F. choke L_2 being placed in series with it. The usual H.F. choke in the plate circuit is shown at L_3, the circuit used being of the shunt-feed type.

When I first hooked up this transmitter I used a ·0005 condenser for C_1 and a ·0003 for C_2, and the coil L_1 consisted of about five turns of gauge 12 bare copper wire wound into a coil of about 3 in. in diameter mounted on an anti-capacity mounting. The aerial was loose-coupled, the coupling between the two coils L and L_1 being variable, for it was found that if the coupling was too tight the valve went out of oscillation when the aerial was brought into tune, or else, if not tight enough to cause this, Q.S.S. and Q.S.S.S. were experienced owing to the wave-lengths shifting from one resonance peak to the other.

Oscillated Immediately

On connecting up L.T. and H.T. and switching the valve on, the set immediately went into oscillation, and after having fixed a suitable degree of coupling between the aerial and oscillator coil not the slightest difficulty was found in shifting the wave-length continuously by rotating the two condensers C_1 and C_2 together.



An ultra-short-wave transmitter which operates on 2 metres.

Having tuned both aerial and oscillator circuits to give the maximum aerial current the effect was then tried of adjusting the balancing condenser C_4, and it was found that it was a very simple matter to find a setting at which the maximum aerial current was obtained.

The greatest control was obtained by means of the grid leak R_2, and it was found that by varying the value of this the amount of the input could be controlled and thereby also the output. In the case of the valve which I was using, which was a Mullard 0/10, I found that the maximum output was obtained when using a grid leak in the neighbourhood of 7,000 or 8,000 ohms. This was, of course, wire-wound and actually had a range of 5,000 to 12,000 ohms. The H.F. choke L_2 consisted of about 30 turns of 24 gauge D.C.C. of an average diameter of three-quarters of an inch, the winding being carried out on the basket-weave principle; this being almost entirely self-supporting its use resulted in a marked increase in efficiency.

Results Obtained

With regard to the results obtained with this transmitter, I am not going to draw on my own experiences, but rather let others vouch for the circuit. I may say in passing, however, that this was the only transmitter with which I ever got any Q.S.L. on the aerial and counterpoise system which I was using at the time. Although a very high aerial current was obtained, this was, I believe, practically all circulating current, since the capacity of the system was very high, and the overall radiation efficiency must have been extremely low, since not only were the aerial and counterpoise very close together but very badly situated as regards surrounding objects.

I showed the circuit to 6 J K, who had been experimenting on 45 metres with somewhat indifferent success. On hooking up the transmitter it functioned immediately, and farther on I give reports which I have received from him as to the results obtained on telephony with this set.

I may mention here, as a matter of interest, that 6 J K showed this circuit to another transmitting amateur who had also been trying to get on the air on 45 metres, and who had been experiencing great difficulty in getting his transmitter to function satisfactorily on this wave-length.

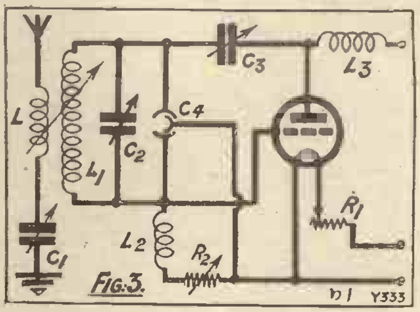
On first seeing the circuit 6 J K's friend was of the opinion that it could not possibly function, and that it was not any good, but having a spare afternoon on his hands he thought that he might as well give it a try out.

"Never-Fail" Set

The circuit was therefore hooked up and a test call sent out, and within three minutes of switching over a reply was received from some 200 miles away.

I therefore think that the title of a "Never-Fail" Transmitter is really deserved by this circuit, and it should be of the greatest interest to those who have been trying 45-metre transmissions with poor results.

During experiments carried out with this circuit it was found that the efficiency peak of the circuit was somewhat sharp—i.e. there is a definite setting of the variable condenser at which the efficiency of the



transmitter as a whole is greater than at any other setting, but by a suitable choice of the inductance L_1 it is a simple matter to get the efficiency peak to fall on the wave-length on which it is desired to transmit. For the longer waves the size of the balancing condenser C_4 will probably need to be somewhat larger.

With regard to the performance of this transmitter on 23 metres I can say little, but though it is sometimes difficult to get it to oscillate down there, it can be done, but it certainly does not seem to function quite so satisfactorily on this wave-length as on the higher ones.

Easily Adaptable

The chief claims for this circuit are that it will oscillate "first go off" on 45 metres, that it is very easy to change from one wave-band to another, that it is simple to tune the aerial and oscillatory circuits together and that small variations in wave-length are not attended by a number of fresh adjustments which have to be made; which so frequently happens with other transmitting circuits. The use of a loose-coupled aerial to which this circuit is particularly suited further assists in giving a steady and pure note, and even with raw A.C. H.T. supply I have received favourable reports as to steadiness of wave-length and note with this circuit.

Lest I be accused of favouritism, however, with regard to my own offspring, I will now give the chief details of a report which has been sent to me by 6 J K, covering tests carried out on a transmitter using this circuit on March 4th and April 3rd of last year.

The transmitter is located at Weston-super-Mare, the aerial being in a poor position and screened by a large hill, house and trees. Two aerials were used in the course of these experiments: No. 1 being 45 ft. long, running up the side of the house to a pole on the roof. Maximum height about 17 ft. above the roof, and it was altogether a very poor aerial. A counterpoise 30 ft. long was used to one side and below the roof. The maximum aerial current obtainable with this aerial was ·28 amp. Aerial No. 2 was a Hertz aerial with parallel feed. The length of the aerial was adjusted in order to obtain the maximum aerial current on 45 metres. The aerial was sloping, its maximum height at one end being 37 ft., the height at the other end being 17 ft. above the ground. The maximum aerial current obtained with this aerial was ·34 ampere.

Low Power Used

The H.T. supply was obtained by means of a hand generator with a maximum output voltage of 600 volts and 30 to 35 milliamperes. Two small low-frequency chokes were used in order to smooth the current, and as these were rather high-resistance components the effective plate voltage was somewhat reduced. In the absence of an accurate H.T. voltmeter it was difficult to tell the exact power used, but the input was somewhat on the low side.

The valves used in this transmitter were an L.S.5 for the oscillator, while modulation was carried out by grid absorption, using either of two valves, namely, a P.M.6 and a D.E.5B. Of these two valves it was found that the best modulation was given by the D.E.5B, since it gave a somewhat greater degree of control.

A wire-wound grid leak was employed which was variable up to 50,000 ohms, the usual value used being in the neighbourhood of 30,000 ohms.

An Amateur's Experiences

6 J K reports on the handling of the transmitter as follows:

"The set was extraordinarily easy to handle. It was only necessary to set the oscillator condenser to the required wave-length, adjust the balancing condenser to give the minimum input current, then bring the aerial condenser into tune and finally adjust aerial and balancing condensers for maximum radiation. No difficulty was experienced in getting the set to oscillate, and the transmitter functioned from the moment it was connected up."

The wave-length employed was 45 metres, and on No. 1 aerial this was by no means the most suitable wave-length for the aerial system to give the greatest efficiency. On No. 2 aerial, however, which was specially put up for 45-metre work, excellent results were obtained. 6 J K says that he has not yet succeeded in getting his set to oscillate on 23 metres, but he had a report from 5 B K, who has also tried this circuit, reporting radiation of ·12 on a Hertz parallel-feed aerial on 23 metres.

Stations Worked

All working was done on telephony, and the following stations are reported by 6 J K as having been worked when using No. 1 aerial:

2 S L, 5 D C, 6 J S (three times), 6 M O, Belfast, 6 A T, 6 T Y, 5 U S, 6 N F, 5 Q V, 2 Q M, 6 N F.

Reports were also received from listeners in Lancashire, six from Nottingham, Hull, St. Albans, Henley, Cheltenham, etc.

No. 2 aerial was worked on April 3rd, and on that day six stations were worked as follows:

5 Q V, 6 L C, 6 B T, 5 I S, 5 A D, and 6 N F.

Listeners' replies also showed a corresponding increase and signals were reported to cut through Q R M much better with No. 2 aerial than on No. 1 aerial.

Since writing these notes 6 J K reports many more Q.S.L.'s. He has also succeeded in getting the transmitter going on 23 metres, but no reports are yet to hand.

In view of the fact that the transmitter is at present in a purely hook-up form, 6 J K considers the results obtained as very satisfactory, especially as later tests were carried out on 230-volt mains with low power in the neighbourhood of 4-6 watts.

The results obtained during May and June are tabulated herewith, while the best report he has had came from Berlin, when working off the mains with 9 watts. He has also received a Q.S.L. from Rotterdam when working with 4 watts on 'phone. Since the transmitter is in a bad locality with an aerial which is badly screened by a hill and trees, I think that I can agree with 6 J K that the results are very good.

Results Obtained During May.

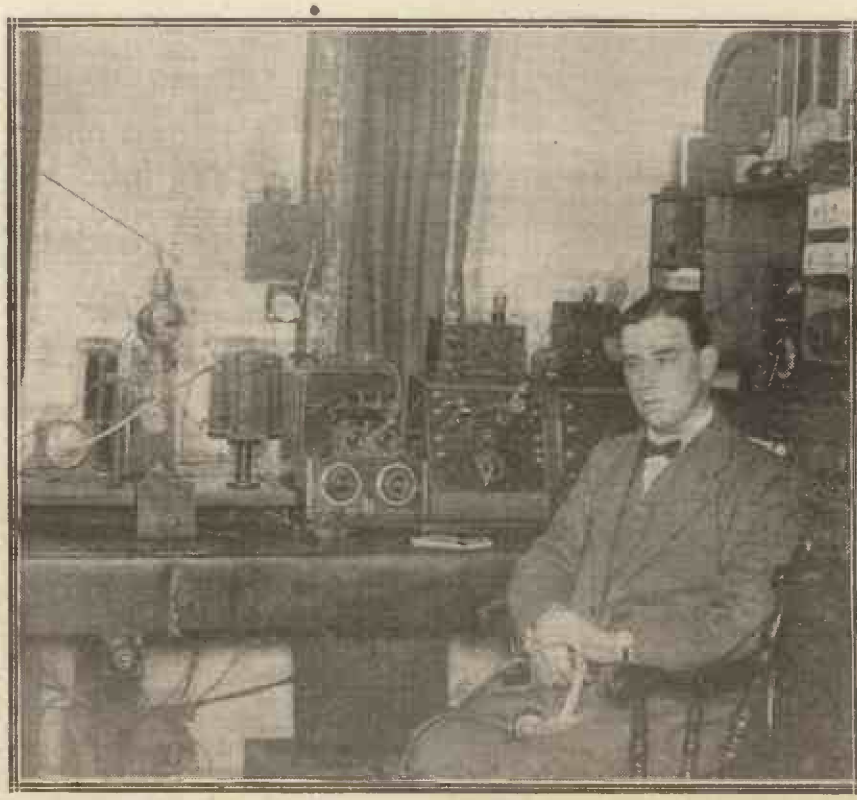
Q.S.O., 27 stations.

Among the reports are two from Broadstairs and Wolverhampton giving his signal strength as R9 on 'phone, using 4 watts.

Results Obtained During June.

Q.S.O., 63 stations. Power, 5-9 watts.

Q.S.L. received from Orleans, Knocke, Paris, Channel Islands, giving an average strength of R5.



Mr. E. J. Simmonds, the well-known amateur who operates station G 2 O D at Gerrard's Cross.

A PAGE OF PRACTICAL HINTS

Earthing an Eliminator. How to Lay Out a Baseboard. Constructing Mains Units.

Earthing an Eliminator

WHEN an H.T. eliminator is used, it is always necessary to break the direct connection between the earth terminal on the set and earth, by introducing a large fixed condenser. Sometimes an earth terminal is provided on the eliminator, the condenser being incorporated in the unit, and the earth lead being taken to that instrument. In other cases it is necessary to join up a fixed condenser near or in the set.

The purpose of this condenser is to prevent the mains shorting to earth via the receiver. This precaution must always be taken, otherwise fuses will be blown and all sorts of trouble caused.

Now, sometimes this condenser remains, while the set is in use at any rate, permanently charged up. Therefore you should not touch its terminals if you would avoid a bad shock. Also such a constant strain is liable to break down the best of condensers, and it should be tested at frequent intervals, say, once a month, to ascertain that it is in good order.

How to Lay Out a Baseboard

THERE are tricks in every trade, and the following tips describe a very simple method and also a very satisfactory one of going about laying out a receiver. This will, of course, only interest those who are in the habit of making their own design. Many follow a published circuit, but do not necessarily follow the actual constructional matter relating to general arrangement.

The process is to first of all collect around you the various components which you intend to use. Then procure a large piece of paper, mark out upon the paper the size of baseboard which you desire, and place the components upon the paper until you are convinced that the arrangement is suitable. Then draw a pencil line round the base of each component, take the components off the paper, and proceed to pencil out the baseboard connections.

You will probably be surprised to find what a mass of wiring results. This may be due to one or two things. Your layout might look nice but not be practicable, or you have connected your points up badly. It must be remembered that there are several ways of connecting three or more points together, and it is often worth while to consider the best possible way of connecting such points. If you are not satisfied, it is a simple matter, and one which takes little time, to go over the process once again and have another try.

This process does not involve the skilled methods of the draughtsman, or any form of calculation of measurements, etc., but there is one point in its favour—it is extremely practicable.

Constructing Mains Units

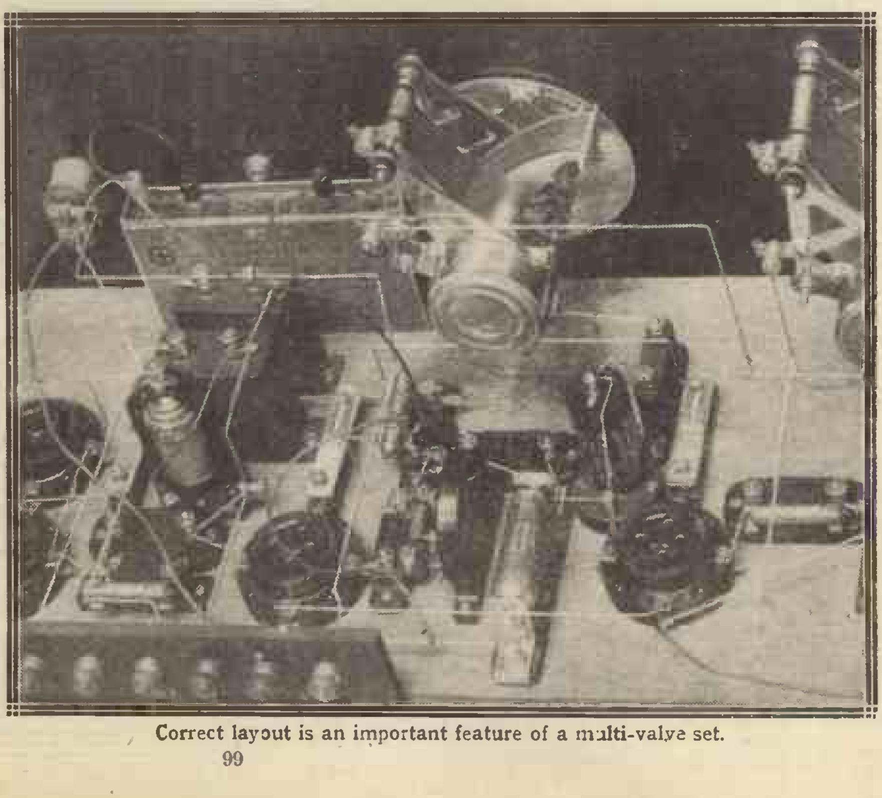
IF you make your own H.T. or L.T. eliminator do not forget that with fuses it is veritably a fact that there is "safety in numbers." The minimum number employed should be three. There will be two terminals or leads going to the unit which will be attached by a flexible cable to the lighting or power point. Before connecting a condenser across these two points, or, in fact, before connecting anything to them, join a fuse in circuit with each lead; then whatever the efficiency of the condensers or other components used the unit, a fair measure of protection is provided.

Third Fuse Necessary

But the cautious constructor will have yet a third fuse. This will be in series with one of the flexible leads close to the power plug or light socket. Even the stoutest of flexible leads is liable to be broken or develop a leak after constant usage, and a fuse situated in the manner indicated will provide protection against any trouble ensuing through this cause.

In most unit circuits there will be a fixed condenser connected across the mains at the input. This condenser will have to stand the strain of the full mains voltage the whole time that the unit is in use. This, then, must be of a very high order of efficiency, and if your mains are of, say, 200 volts, use here a condenser tested to at least one thousand volts.

If you are using an H.T. eliminator always switch off the mains current before you make any internal adjustments to the set, such as changing valves, adjusting grid bias, and so on, and before touching any of the fixed condensers used in the unit, or as by-passes to the H.T. in the set, see that they are discharged. Take a wooden-handled screwdriver and rest the metal part of this across the terminals of the condensers concerned.



Correct layout is an important feature of a multi-valve set.

WIRING A RECEIVER

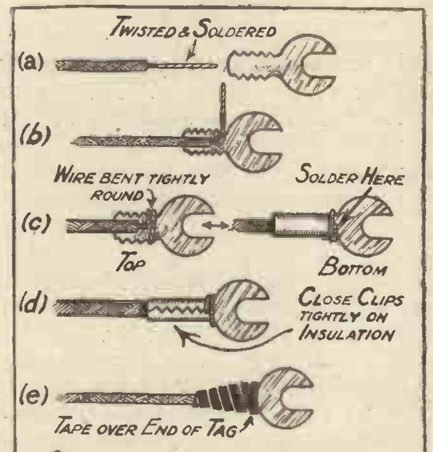
—continued from page 56

To solder a wire to a tag, proceed in a similar way. Hold the tinned end of the wire in firm contact with the tag, and lay the face of the bit carrying the solder along the wire, resting the face of the bit at right angles to this on the tag. If the bolt on which the tag is secured is mounted on ebonite, slacken the nut which holds the tag before you apply the iron. This will prevent the heat of the iron from reaching the bolt so readily, and obviate possible trouble which might arise from the softening of the ebonite. Wait till the joint is cool before tightening the nut again.

Soldering Spade Terminals

When a tag is situated in an awkward corner, place the wire in the position which it will finally occupy when soldered to the tag, make a mental note of the relative positions of the wire and the tag, and remove the latter from its bolt. Now solder together the wire and tag outside the receiver, and replace the whole assembly. If you are unable to remove the tag from its position, a smaller iron may be temporarily brought into service to make the joint.

Rigid wires to be joined together end to end should be cut so that they overlap for about ½ inch. Hold



STAGES IN THE ATTACHMENT OF A SPADE TERMINAL TO A FLEX LEAD.

the ends in position with a pair of pliers, and rest the face of the iron flat across the point of overlap, so that it touches both wires. Very little solder is required for a joint of this kind, the application of excess leading to the formation of an untidy drip hanging below the joint. If you experience any difficulty in keeping the two wires together while making the joint, put a turn or two of cotton round the wires at one end of the overlap. This can be pulled off when the joint is done.

A "T" joint is made in a similar manner, the branching wire being bent at right angles at the end. End-to-end joints without an overlap, and right-angled joints without a bend in the branching wire, may look neat, but they are mechanically weak.

"Close" Work

At some time you may be faced with the problem of making a second soldered joint on a wire in close proximity to one already completed. The first joint will then "come unstuck" just as you have finished the second. To get over this difficulty you must in some way localise the heat of the iron, so as to avoid melting the solder on the first joint. To do this, wrap a piece of damp rag round the first joint while you are working on the second. A damp rag is also a useful safeguard against

(Continued on page 102.)

WIRING A RECEIVER

—*continued from page* 100

damage to the panel when you are soldering to a large terminal which needs a rather prolonged application of the iron. Wrap the rag round the shank where it passes through the panel, and you will be unlikely to do any damage to the panel.

The jointing of flexible wires, after tinning in the manner described, can be treated in the same way as rigid wires. In attaching spade tags to flex leads, use the clips on the tags to grip the end of the insulation. Solder the flex to the tag first, or the heat of the tag will melt the rubber of the insulation; then bend over the clips and finish off with a serving of adhesive tape.

Soldering Fire Wires

In joining very fine wires, it is only too easy to overheat the wires, and even to melt them. For such joints use a solder with a low melting-point, and apply it in the following way. Run some of the solder on a hot iron and allow it to fall in drops from a height of a few inches into a tin, the drops being scattered about and not falling one on top of another. The result will be a number of thin flakes of solder. Break off a small piece of one of these, smear it with flux, and wrap it round the ends of the fine wires. The merest touch with the iron will be sufficient to unite the wires.

This completes the making of the joints most commonly met with in the construction of the receiver itself. It remains to deal with joints outside the receiver—those in the aerial and earth wires.

Joints in the aerial wire, or in any wire which is similarly in tension, must be mechanically strong as well as electrically sound. A "dry" joint in an aerial—that is to say, one which is made without the help of solder—may fulfil the former condition, but it is unlikely to remain a good electrical conductor after exposure to the weather for a few weeks. A film of oxide will form on the strands at the joints, and will partially insulate the jointed ends from each other, increasing the resistance of the aerial system.

Aerial Connections

To join together two ends of seven-strand aerial wire, bind the wire tightly with a few turns of copper wire (about 26 S.W.G.) two inches from the free ends of the strands. Next separate the strands as far as this binding and thoroughly clean them with emery cloth. Hook together two strands, one from each end, and pull the bindings as close together as possible. Take a turn with each of the two "hook" strands over the remainder of the strands in opposite directions; then remove the binding.

Lay the six remaining strands on each side of the joint along the standing part of the wire, bedding them down between the strands of the standing part as neatly as you can. Bind the two "hook" strands round as far as they will go on each side of the joint, after which continue with the other six strands on each side, keeping the adjacent turns close together. The joint is then ready for soldering.

Put a little flux on the centre of the joint and hold a good hot iron in contact with it underneath, at the same time pressing a stick of solder on the top. When the wire gets hot enough, the solder will run down into the centre part of the joint. Wipe off any surplus with a rag before it cools. Solder a length of only about half an inch at the centre of the joint, so that the joint may be easily taken apart again if required.

The Earth Lead

To join a flexible lead-in wire to the aerial wire, strip the insulation from the last inch or so of the flex. Clean the aerial wire with emery cloth, and with a spike separate the strands. Push the end of the flex through between the strands (there will, of course, be four strands on one side of it and three on the other) as far as it will go and lay it along parallel with the aerial wire. Bind the whole length of the joint with 26 S.W.G. bare copper wire, and solder about $\frac{1}{4}$ inch of it where the flex passes through. Finally cover the joint with adhesive tape to prevent moisture from entering the end of the flex.

Nowhere is soldering more important to ensure a satisfactory and constant connection than in the earth lead. The task of soldering the earth lead to a water pipe actually containing water is not recommended to the amateur. The pipe must be emptied of water, and even then the operation calls for skilled attention. A length of a few feet of iron pipe driven vertically into the ground outside, however, forms an excellent earth connection, and it is not difficult to solder the earth lead to a pipe of this description.

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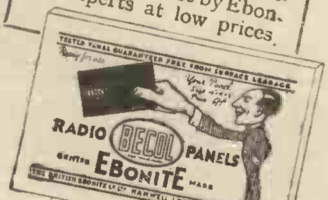

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Model "D"

IN OUR TEST ROOM

—continued from page 90

A New Brandes Product

Messrs. Brandes, Ltd., are now producing a "slow-discharge" current accumulator which is manufactured under the Oldham activation process. It embodies the well-known laminated plates, a girder-like construction which gives these batteries considerable robustness. There are two types, the R.B.10 and the R.B.20, which, having 10-ampere and 20-ampere hours actual capacities respectively, retail at 5s. 6d. and 9s.

Clix Rainbow Terminals

Lectro Linx, Ltd., recently sent us one of their new Clix Rainbow Terminals. The feature of this terminal, which is of the universal type designed to take all kinds of connectors, is its brightly-coloured head and the coloured collar which is supplied with it. This coloured collar is for fixing to the pin or spade connection used with the terminal. The idea is that you connect the leads to a radio set by colour, with every lead wearing a neat collar corresponding in colour to a terminal head. This is an ingenious scheme which should go a long way towards reducing expensive valve burn-outs caused by mistakes in connecting up. The "Rainbow" is a solid, well-made article, and sells at 5d.

Loud-Speaker Diaphragm Paper

The Electron Company, Ltd., makers of the well-known "Six-Sixty" valves, have produced a specially prepared paper for cone loud-speaker diaphragms. In appearance this paper seems to be a cross between thick brown paper and thin cardboard, but, from its texture, it is obviously a material specifically manufactured for its stated purpose. It is sold in two sizes, complete with full instructions and directions for cutting, at 2s. 6d. and 3s. 6d. The paper itself is very clearly marked out, and it is literally but a few minutes' work to prepare a diaphragm of the conventional convexity all ready for mounting in position.

We replaced the diaphragm of an existing loud speaker with one prepared from this "Six-Sixty" cone loud-speaker paper, and we must say that the results were most gratifying. The form of cone which the design fashions, and the nature of the material, gives the degree of that so-called stiffness-mass ratio which is lacking in not a few commercial cones. Reproduction, in general, was noticed to be bright and pleasing,

A wave-meter made by Messrs. Bowyer-Lowe which covers a wave-length range of from 150 to 2,000 metres.

although constructors should remember that much of this must depend upon the mounting of the cone and the drive and unit employed.

(Continued on page 105.)

IN OUR TEST ROOM

—continued from page 104

P.M. Grid Leaks

Some fifteen years ago, quite by accident, a scientist discovered grid-leak rectification. Since that momentous day millions of grid leaks have been used, and an interesting speculation is, how many of the sum total of radio-set troubles have been caused by these small, cheap, but vital components? We fear that the very inexpensiveness and simple nature of the grid leak has earned it an undeserved and illusionary unimportance.

Not so very long ago it was common practice for constructors to make their own grid leaks out of little pieces of paper inscribed with pencil lines, but comparatively recently the necessity for employing grid leaks of dependably constant value has been universally recognised. It is known now that a grid leak must be of a certain value—a value which will depend upon its accompanying circuits. Also, it must retain this value constantly through the vicissitudes of usages and changes in atmospheric and temperature conditions.

But a grid leak of such a perfect nature need not be an expensive article. For instance, the Mullard people have a range of P.M. grid leaks of very good orders of electrical efficiencies which retail at the very satisfactory low price of 2s. 6d. each. These P.M.'s are similar in appearance to other types of grid leak, but they each possess a constant high-resistance element on a core of glass, the combined core and resistance element being ingeniously mounted in an ebonite tube fitted with metal caps.

It is stated that exhaustive tests are applied to each individual resistance before being passed as satisfactory, including tests at various applied voltages up to 250 volts to ensure that the resistance value remains constant, and we must say that the Mullard P.M. grid leaks that we have tested have proved closely accurate in respect to their rated values. There are seven values, ·1, ·5, 1, 2, 3, 4, and 5 megohms, while it is stated that intermediate values can be supplied if specially ordered. A neat little holder fitted with terminals and soldering tags is available at 1s. 3d.

(Continued on page 106.)

IN OUR TEST ROOM

—continued from page 105

Cosmos A.C. Components

We have recently had the opportunity of testing a Cosmos L.T. battery eliminator for A.C. valves. This is a unit complete with 10 ft. of flexible cable and an adapter for plugging into a lamp holder, which will feed any number of Cosmos A.C. valves up to a maximum of five, without using rheostats. A potentiometer which is fitted ensures "silent" operation, even when a sensitive receiver is operating from noisy mains. A special screw plug allows the instrument to be adjusted to suit the voltage of the supply mains, and it is notable that this control is so arranged that it is impossible for the operator to receive a shock.

There are two types, one for 100 to 110 volts A.C. mains at £2 10s., and another for 200 to 240 volt mains at the same price. These will function at any periodicity from 40 to 100 and the output is 5 amperes at 4 volts. A transformer such as is incorporated in these units with an output of 5 amperes at 4 volts is available separately at £1 10s. Further, there is the type B transformer having two secondary windings. This is for use with the type S.P.42 U. full-wave rectifying valve, used in conjunction with H.T. units. The price of this transformer is £1 14s.

Two L. and P. Components

It may be remembered that we recently had under review a two-way coil holder produced by the London and Provincial Radio Co., Ltd., of Colne Lane, Colne, Lancs, the outstanding feature of which was a scaled dial allowing calibration readings to be taken of the position of the moving-coil holder. The L. and P. people have now introduced an interesting variation of this scaled reaction-coil holder.

It is known as the "High-low," and both the moving block and the fixed block each carry two complete coil sockets, so that four coils can be accommodated—two for the aerial, and two for the reaction. The two moving coils face their respective fixed coils, and as the coil holder is adjusted each pair maintains correspondingly the same relative positions. It is like having two two-way coil holders and ganging them and operating them with the one control. The object of this is to enable both the normal broadcast band and the higher wave-length, including 5 X X, to be covered without the necessity of pulling out and plugging in new coils.

By means of a simple switch, either pair of coils in the L. & P. "High-low" coil holder can be brought into circuit as desired. It is necessary to use only one variable condenser. It is certainly a sound and attractive scheme and one which may well bias many constructors in favour of the swinging coil method of obtaining reaction. The price of the "High-low" is 14s.

We also recently received an L. & P. "Variohm." This is a baseboard-mounting filament resistor of interesting design and construction. It is practically dustproof, the adjustment being by means of a small knob which projects through a horizontal slot on the top of the device. A useful feature is that it is calibrated fairly accurately. The "Variohm" has a resistance range of from zero to 10 ohms with a definite "off" position and retails at 4s.

POINTS TO NOTE

When driving screws in inaccessible places where they cannot be held with the fingers, it is a good plan to pass the screw through a strip of paper or stiff cardboard, which makes a very good holder.

* * *

Instead of using a pulley at the masthead, with the danger of the halyard fouling it, a large shell-type insulator may be employed. If this is of ample proportions, there is no danger of breakage or of fouling due to the halyard fraying.

* * *

Before commencing to drill a panel it is a good plan to fold a newspaper and lie it on the work-bench to prevent scratches.

* * *

A good keyhole saw for small holes can be made from an old hack-saw blade, filed down and provided with a wooden handle.

* * *

Condenser-controlled reaction is not so efficient on the Daventry (5 X X) range as on the shorter wave-band.

A PRACTICAL CHARGING UNIT

—continued from page 21

panel and the stopper in the top of each cell removed. Care must be taken that the positive on the panel is joined to the positive on the board and the negative to the negative. On closing the switch the lamps will light and the ammeter should register 2·5 amps.

The small shorting leads should now be placed in the right-hand socket so that the ammeter is out of circuit. This shorting arrangement is to prevent the ammeter being continuously in use.

Hydrometer Essential

After several hours the accumulator should be examined. With the aid of a hydrometer, which should be an essential feature of the home-charger's equipment, take the reading of each cell. This should show 1·240–1·250 if the cells are fully charged, but in the case of accumulators designed for car work it will probably be slightly higher, 1·290–1·300.

When charging H.T. accumulators the process is far more tedious as the number of cells has been multiplied many times. The charging rate of such an accumulator is very low, usually between ·5 and ·1 of an amp. The actual value of the lamp required to limit the charging current is easily obtained from the following formula.

$$W = \frac{E^2C}{(E - 2\frac{1}{2}N)}$$

W = Wattage of bulb required.
E = Voltage of charging mains.
C = Charging rate of accumulator.
N = The number of cells in series.

Different Fuses

We will assume that 50 cells are to be charged from 200-volt mains at 0·1 amp.

$$\therefore W = \frac{200 \times 200 \times 0{\cdot}1}{200-(2{\cdot}5 \times 50)}$$

$$\therefore W = \frac{4000}{75}$$

$$\therefore W = 53$$

Owing to the fact that it is not possible to obtain a 53-watt 200-volt lamp, it will be necessary to use two lamps (a 20 and a 30-watt) in parallel. The charging rate will then be approximately one-tenth of an amp. When charging this type of accumulator 1-amp. or 0·5-amp. fuses should be employed in place of the 5-amp. fuses already in the cut-outs.

THE YEAR'S PROGRESS

—continued from page 18

There are also certain aspects of radio development that are worthy of mention, apart from broadcasting. Direction-finding is one case in point. Trinity House has recently authorised the erection of new wireless "lighthouses" at several of the danger points along our coast. These are arranged to transmit automatically a rotating beam of wireless signals by means of which ships can pick up their bearings in foggy weather when the ordinary flashing or fixed lights cannot be seen.

Automatic Alarms

Another interesting development is the installation on certain types of ships of automatic "pick-up" devices, which are arranged to ring an alarm bell directly the S.O.S. signal is received, irrespective of whether the wireless operator is on duty or not. This type of apparatus has now been perfected and standardised to the point where it can be relied upon to function properly in the face of heavy atmospherics or even when interfering Morse threatens to mask the S.O.S. appeal.

Television is another subject of wide appeal. Unfortunately in this particular instance anticipation has exceeded realisation. In spite of a published promise that the end of the present year would see a popular £30 television receiver on the market, nothing of the kind has materialised. Nor, to speak frankly, does it appear to be yet in sight.

Television will certainly come, sooner or later. There is no doubt that progress has been made and difficulties are slowly being overcome. At the same time the first receivers will undoubtedly prove too expensive for the ordinary listener's purse, whilst there is no room under present conditions in the ether for the broad wave-band necessary to transmit a continual service of pictures.

Mains Unit

Indications point to the cinema theatre as the first practical user of television, because here the expensive installation necessary can be covered by the admission fees of a large audience. Also for such use a special zone of the ether could be allotted occasionally for the transmission of spectacular events of unusual interest.

On the receiving side, the trend of recent development has followed certain well-defined lines. In the first place the almost universal use of power valves on the low-frequency side has emphasised the problem of providing an adequate supply of high-tension current. This has created an interesting struggle for survival between the wet and dry cell type of battery on the one hand, and mains supply units on the other.

Loud-Speaker Tendencies

The ideal of a battery-less receiver has also been brought nearer by the introduction of the new type of valve in which a specially robust filament is fed with a comparatively large current taken directly from the mains. The heat radiated by this filament energises a second filament or cathode of the dull-emitter type, which liberates the steady flow of electrons necessary for the functioning of the valve.

Another outcome of the power valve is the increasing popularity of the cone type of loud speaker as compared with the original horn model. The former requires a somewhat larger energy input for satisfactory operation than the latter. The new power valves have solved this question, and the superior tone qualities of the large diaphragm have done the rest.

The other outstanding feature of development relates to the high-frequency side of reception. Now that valves are comparatively inexpensive, the advantages of using one or more stages of high-frequency amplification are becoming more manifest, particularly as an aid to selectivity.

Screened Valves

The introduction of the new type of internally-balanced valve, such as the Round screened-grid type and the Robinson Interdyne, has greatly simplified the problem of tuning, so that a set with two or three high-frequency stages can now be controlled by means of a single dial almost as easily as a crystal set.

Finally, the use of neutralised high-frequency stages whether the balancing of the electrode capacity is accomplished inside or outside the bulb, has greatly reduced local interference due to self-oscillation, since such sets, when properly adjusted, are incapable of energising the receiving aerial.

THE REGIONAL SCHEME

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Midlands area to be served under the system of ten wave-lengths, but the B.B.C. states that in such a case it has in mind various alternative expedients. Anyway, our many readers in the Midlands may take it for granted that the B.B.C. guarantees that if the result of the application of the Regional Scheme to the Birmingham and Midlands area district is unsatisfactory, then it will be supplemented in such a way as to carry out the B.B.C.'s pledge, that Birmingham and Birmingham's artistic resources will be fully developed and that listeners will in no way suffer.

For the moment, then, these definite statements made by the B.B.C. should serve to allay the doubts which have arisen about the Regional Scheme. That these doubts were justified there can be no question, for so much has been said and written about the Regional Scheme that confusion has inevitably resulted in the minds of many students of broadcasting. But the position is now clearer and it turns entirely on the result of the experiments now being carried out at 5 G.B.

May Not Materialise

We are not in a position to say whether the experiments up to date have proved fully satisfactory to the B.B.C. technicians. Perhaps it is not fair to ask at this stage, for the experiments are of such a nature that they must be carried out over an extended period, and although 5 G B has been in operation for some months now the full value of those experiments and the results they will have upon the Regional Scheme cannot possibly be determined much before August next.

In the meantime, therefore, we suggest that listeners do not worry themselves unduly about the Regional Scheme because even now nothing may come of it. It is a very good scheme on paper, and we do not in any way wish our readers to think, or our friends at the B.B.C. to think, that we are decrying it. It is only fair to point out, however, that on the B.B.C.'s own evidence there is a possibility that this scheme will come to nothing.

If it does, it will be no fault of the B.B.C.'s. Something else will be devised which will satisfy the needs of the many and various listeners of Great Britain.

RADIO ABROAD

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is proceeding to arrange for an "orchestra" of twelve of these sets. In order to "play" the instrument it is only necessary to move the hands about before it in ways which, of course, have to be learned by practice, just as it is necessary to practise the art of pianoforte playing. Professor Theremin states that the new musical instrument will free the composer from the despotism of the 12-note tempered pianoforte scale, to which even violinists at present must adapt themselves. The composer can now construct a scale to any desired intervals; he may even have intervals of 13ths if he so desires. An entirely new range of tone colours is available, and instead of the usual average of, say, 20 tone colours represented by that number of different instruments, Professor Theremin opens up an almost limitless field, including thousands of tone colours.

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OPERATING THE VIKING IV.

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To obtain the maximum possible faithfulness of reproduction upon strong signals, particularly those from the local station, it is usually preferable to employ the other scheme of rectification, namely, anode-bend, which is obtained by inserting the plug in the left-hand socket. This brings into operation the small bias battery carried upon the baseboard of the set, and the voltage here should be adjusted in accordance with the particular strength of signals which it is desired to receive. For all moderate signals about 1½ volts will be the correct voltage for most valves, while for those from a very powerful local station a considerably higher voltage will usually be desirable. About 4½ volts is then a desirable figure, although if the signals are extremely powerful 6 volts may sometimes be used with advantage.

Neutralising

After attending to these preliminary adjustments we come to the actual operating details, and the first point to receive our attention is that of obtaining the correct

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neutralising adjustment. Here we have a choice of two methods, these being the "local station" method and the "reaction demand" method. Of these the former is the most easily carried out, although it is only of use to those who have a strong local transmission, whereas the other gives more accurate results, but is rather more difficult to carry out. Probably the best scheme to adopt is to use first the easier method, and then to check this by the more accurate, but more difficult, reaction method.

Local Station Method

In the "local station" method the procedure is first to set the reaction and the neutralising condenser at minimum. Then place one of the tuning dials near the middle of its scale and proceed to swing the other throughout its whole range. Note whether oscillation takes place at any setting while this is done, and, if it does, increase the capacity of the neutralising condenser gradually until oscillation is checked everywhere. Having done this, increase the capacity of the neutralising condenser just a little more, for safety's sake, and then tune in the local station (of course, with the volume-control resistance switched out of circuit). Now proceed to turn out the high-frequency valve, and then re-tune until the local station is heard as strongly as possible. If necessary, bring up the reaction adjustment to an adequate strength of signal for test purposes.

Now proceed to increase the capacity of the neutralising condenser gradually, at the same time re-tuning a little as may be necessary, to keep the local station at the greatest strength. You will presently find that as you increase the capacity of the neutralising condenser, you will reach a point at which the local station becomes practically inaudible, or perhaps entirely inaudible, and on either side of which it reappears. This is the approximate neutralising point, and, having found it, you can turn on the filament of the H.F valve once more and proceed to search for distant stations. Having found a fairly weak station, bring up the reaction control until the set

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OPERATING THE VIKING IV.

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is on the very verge of oscillation, carefully re-tuning slightly as you do so, to make sure that the station is maintained at the exact tuning adjustment. Now try varying the capacity of the neutralising condenser. If this is exactly at the correct setting, varying it either way should cause the set to break into oscillation; but each time you alter it stop a moment to re-tune slightly on the dials. If you find that varying the neutralising condenser in one direction takes the set a little farther off the oscillation point, this means that you are getting nearer to the correct neutralising point, and you should then bring up the reaction condenser until the set is once more on the edge of oscillation, in order to test the new setting. Again turn the neutralising condenser a little either way, and, if you have now found the correct point, you will find that any movement causes the set to break into oscillation. Proceed in this way until you have got the exact setting, and you can then be sure that the neutralising has been correctly done. The details of the " reaction demands " method have been given on several occasions recently.

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Broadcast Chain

An international broadcast circuit of the United States, stretching from the Atlantic to the Pacific, is an enterprise of the Metro-Goldwyn Motion-Picture Corporation, and is in immediate prospect although details have not yet been published. As motion pictures have developed the super-production and the super-theatre, so this latest development of the chain system is said to comprise a super-circuit of sixty stations with new ideas for entertaining the radio public.

Talking Movies

A method has lately been perfected in Germany for combining the movies with wireless for the purpose of enabling broadcast lectures to be illustrated in numerous cinema theatres. In each cinema auditorium where the broadcast lecture is to be heard, the film is run through a projector which is geared to an electric motor synchronised with the motors in all the other theatres in which the same film is being shown and also with that by which a copy of the film which is being run over in the broadcasting studio. The lecturer watches the screen in the studio and gives his lecture to correspond. It therefore reaches the various audiences in the cinemas throughout the country in precisely the same relation to the film which is being shown.

Stunt Relay

By means of a photo-electric cell, a flashlight of only one candle-power in New York switched on a searohlight of about one and a half million candle-power in Charlottesville, Virginia. When the flashlight beam fell upon the light-sensitive cell, an electric current was sent over a wire and worked an electric relay which switched on the power for the main searchlight.

In the same way, the light from the searchlight at Charlottesville worked a photo-electric cell which turned on the flood lights in the City Hall, New York City. This light illuminated a portrait of Thomas Jefferson, in whose honour the Charlottesville beacon was named. The beacon is intended as a guide for aeroplanes and is said to be the largest searchlight ever made.

THIS YEAR'S SOLODYNE

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The H.F. valve-filament wiring calls for a word or two. Wires run down from each positive tag through the holes A and B (see blue print), drilled through the base of the set. They are insulated with Systoflex where they pass through, are joined together beneath the baseboard and emerge again at C.

Remaining details must be covered very briefly pending fuller treatment next month. The H.F. grid leaks will be either 1 or 2 megs. and it is best to start with the lower value first. A safety fuse can be incorporated if desired by breaking lead X on blue print. (See point-to-point list and photos.) The fourth coil base (" Special Five " type) provides a means of altering the number of turns in the aerial circuit, and bringing in the series condenser when required. (See photos and blue print.)

Coil construction involves the use of Litz wire, and it is therefore advised that these be purchased (Burne-Jones, Collinson, Peto Scott, etc.), but for the benefit of the skilled constructor details will be given next month.

A final point—if desired, complete sets of screens can be obtained from Messrs. E. Paroussi.

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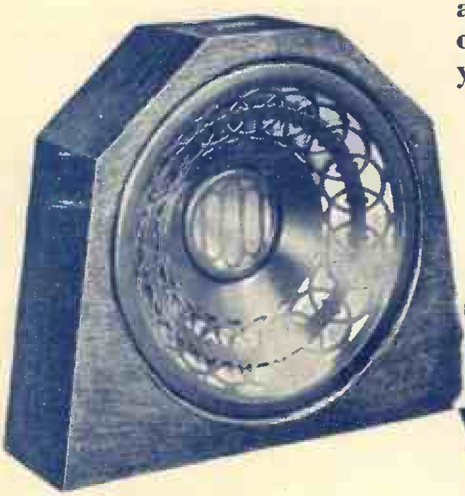

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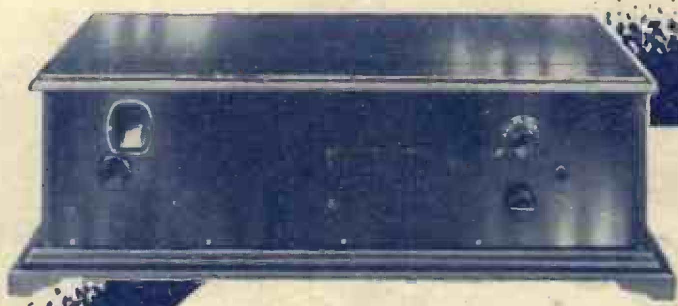

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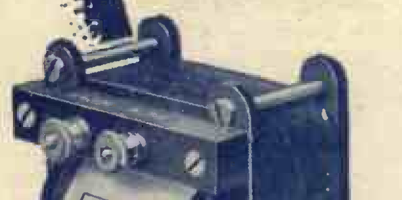

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